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The Genetic View-point: DR. ALBERT F. BLAKESLEE 571

An Optimistic View of the Evolution of the Sciences: DR. VIRGIL F. PAYNE 577

Obituary:

Raoul Gautier: DR. WILLIAM BOWIE. *Whitman Howard Jordan; A. A. Himwich. Recent Deaths* 579

Scientific Events:

The Third International Conference on Bituminous Coal; The Laboratory of Anthropology at Santa Fe, New Mexico; National Research Fellowships in the Biological Sciences; The Diamond Jubilee of the St. Louis Academy of Science; The American Academy of Arts and Sciences 581

Scientific Notes and News 584

Discussion:

The Program of the University Association for the Study of Calendar Reform: DR. C. C. WYLIE. *Plural Fractions and Other Fractions:* W. EDWARDS DEMING. *The Accumulation of Strong Electrolytes in Living Cells:* DR. S. C. BROOKS. *A Curious Color Phenomenon:* DR. PAUL E. KLOPSTEG. *The Auto-traction Hypothesis of Crustal Dynamics and Mechanics:* PROFESSOR J. S. DELURY 587

Scientific Books:

Delporte's Atlas Céleste: DIRK BROUWER. *Lingnan Science Journal:* DR. L. O. HOWARD 590

Scientific Apparatus and Laboratory Methods:

A Modification of Krogh's Differential Manometer: DR. DAVID E. FINK. *The Phyllotax—A Practical Apparatus for Demonstrating Divergence:* JACQUES ROUSSEAU 592

Special Articles:

Onchocerciasis in Guatemala: PROFESSOR RICHARD P. STRONG. *Intranuclear Inclusions in Laryngotracheitis of Chickens:* OSKAR SEIFRIED. *Ionic Equilibria in the Serum in Relation to the Critical Temperature:* DR. P. LECOMTE DU NOÜY. *The Possible Rôle of Micro-organisms in the Precipitation of Calcium Carbonate in Tropical Seas:* WERNER BAVENDAMM 593

Science News 10

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THE GENETIC VIEW-POINT[1]

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$$(A+\frac{hD}{2})\cdot(Z-\frac{hD}{3})$$

THAT I am a retiring president to-night is not my fault. I tried not to do it. I suggested to your secretary that in the future the president of the society make his retiring address the year after he presides and offered to forego or postpone my retiring address this year to set the scheme in operation. Your secretary refused to permit this innovation. (The American Naturalists, I now realize, is one of those societies which is run by the secretary). "I have had trouble enough now," the secretary said, "in trying to explain why the society elected the president they did. If the president should hang over another year before he retired, I should have either to remember the old excuses or to invent new ones. If I had my way," he said, "the formalities of the society would be confined to one day at the annual meeting. Let the president be elected and clothe himself with the insignia of his office in the morning, preside in the afternoon, and retire in the evening, at the Naturalists' dinner. The rest of the year the society can best do without a president altogether, while the secretary runs the society with the aid of his stenographer."

The secretary's arguments were hard to combat. So I tried next to obtain a substitute, an eminent foreign biologist who happened to be on a lecture tour in this country. This suggestion of a substitute met with the immediate (and I might say enthusiastic) approval of the secretary. All seemed working out to the welfare of the society as well as to the pleasure of the secretary, when I received a letter from my

[1] Presidential address delivered at the annual dinner of the American Society of Naturalists, Cleveland, Ohio, January 1, 1931.

substitute calling off his substitution. The secretary was helpful, as ever. He sent me a list of past presidents' addresses and offered fatherly advice: "Don't talk too much about your own work, but use it as a point of departure. Follow the trends of your predecessors." I have tried to comply with this admonition.

The reason for my title is two-fold. In the first place, it was necessary to send in a title, in response to the secretary's telegram, before it was possible to decide upon a subject for discussion. In the second place, it seemed desirable to follow the cryptic trend started by my immediate predecessor, if only to confirm the law of geologic evolution that too great departure from the normal may lead to extinction of the line. I may be sharing the thoughts of an armored dinosaur, if he had any thoughts at being the last of his line.

The last president took as his title "Kim Kurmah." He *said* it was Sanskrit and meant "Where are we at?" I am still skeptical as to what Kim Kurmahs really are. They sound to me more like a fermented health drink made from mares' milk and consumed in the Caucasus. Just to confirm a suspicion, I should like all those who looked up in the dictionary to see what the real meaning was of Kim Kurmah to please raise the right hand. No one raised a hand and no one here, therefore, looked up the meaning of these cabalistic words. Since Dr. Parker is not present to explain how he found his title last year, we may assume that he got the words only by hearsay. My simple experiment to-night with the members of the American Naturalists is encouraging to the present speaker. It shows what a retiring president of the American Naturalists can get away with when his audience knows he is actually retiring.

Now *my* title to-night is relatively simple. Its purpose was not to conceal thought but to develop thought. Probably many of you have already worked out its meaning as I had to do. As the secretary suggested, the formula is based upon Datura (D), the haploid Datura number of chromosomes (hD) is twelve, hD over 2 is therefore 6. If we remember our alphabet we will see that A plus 6 brings us to G. Similarly, Z minus hD over 3 means the subtraction of 4 from Z or the letter V. It will be seen that the formula $(A+\frac{hD}{2}) \cdot (Z-\frac{hD}{3})$ has thus given us the initials G.V. Since there are approximately 7,500 words beginning with the letter G and approximately 3,000 beginning with the letter V in Webster's unabridged dictionary, the initials G.V. could stand for any one of some 23,000,000 combinations. The announced topic, therefore, gave a rather wide choice of subject for discussion. If one were to use foreign words such as Sanskrit, the choice would be still greater [especially if one attributed meanings to such Sanskrit words without looking them up in the dictionary as the last president may have done]. In seeking two words to fit these initials I confined myself, however, to the English language. I tried to find a single word which would represent the most important concept in scientific research. This I believe I have found in the word "view-point." As a geneticist, I might reasonably be expected to touch upon genetic aspects. And the letters G.V. easily resolve themselves into the title "Genetic View-Point." In arriving at our subject for discussion we have used mathematics in the way in which we feel mathematics should be used in biology, not to lend an air of erudition nor as an end in itself, but as a means to an end.

It need hardly be argued that the mere accumulation of facts is of little value in science except as they are organized and contribute to new view-points. A species new to science, or a new 3 to 1 ratio, of itself has little interest to advanced workers. Loose sand and unrelated facts are of equal value in the construction of a concrete building and in the erection of an edifice of science. View-points may be good or bad, may be based upon a firm foundation of interrelated facts or upon assumptions and speculative analogy. In any case our view-points consciously or unconsciously determine the direction of our research and color the interpretation of our results. The establishing of fruitful view-points, and not the amassing of facts, is the goal of advanced research.

Evolution and the concepts of genetics form two major view-points of biology. The evolutionary view-point dates its birth from the publication of the "Origin of Species"—by general agreement the most influential book of the nineteenth century. The evolutionary view-point has not only revolutionized our ideas regarding the origin of species and given a meaning to a mass of facts in biology, but it has also influenced other phases of human thought. At its birth, it was at once realized that acceptance of the evolutionary view-point would render impossible a literal interpretation of the scriptures. It was at once bitterly combatted, therefore, by those theologians who were unable to adjust themselves to laying the emphasis upon the spiritual rather than upon the mechanistic values of religion.

The genetic view-point is almost wholly a twentieth century product, although the progeny test—*i.e.*, determining the genetic constitution of individuals from the character of their offspring, was developed chiefly in the nineteenth century. Mendelism was born, strictly speaking, in the nineteenth century, but the infant's birth cry attracted no attention. The child was kept in suspended animation for some 35

years, until 1900, when it was independently rediscovered by three botanists; Correns, deVries and Tschermak and taken out of cold storage. For this second birth, Bateson assumed the office of godfather and gave Mendelism and related subjects the name of "genetics." In the first decade of the twentieth century deVries gave us the mutation theory and another botanist, Johannsen, gave us the pure line theory. In the second decade, the banana fly was discovered as an object of investigation, and genetics became no longer chiefly a botanical activity.

The growth of the genetic view-point is too recent to need recounting in detail. It may be profitable, however, to compare it for a moment with that of the evolutionary view-point. We may use the progeny test of ideas and note the influence of these two view-points upon the direction of research. The new ideas of evolution stimulated observation and speculation and broadened the field of vision. It apparently did not increase experimentation. Darwin, to be sure, was a good botanical experimenter, but his disciples as a class did not follow this part of his example. Genetics on the other hand was born of experimentation and has made experimentation the basis and final test of hypothesis. It has thus limited speculation and narrowed the field of view.

It will be profitable to the biologist to know more of both these points of view. The study of evolution should, and I believe will, become experimental. Geneticists should take more account of the observations of those who have become familiar with plants and animals in nature, past and present. Life as we know it to-day is the resultant of a continuing series of experiments on a grand scale. They offer a challenge which the geneticist can not long continue to decline. The problem is a task for joint attack by workers with different view-points. An example is offered by taxonomy and genetics. These two fields appear to be separated at present by a fence of mutual distrust and misunderstanding. The taxonomist seems to think that the conditions of a genetics experiment are entirely artificial, and hence conclusions drawn from them have no relation to what exists in nature. Plants and animals under cultivation are not good species and hence not to be considered seriously by the taxonomist. I have been told, for example, that since the jimson weed was only a weed and not known in the wild, it was not a species; that I ought to study some real species from nature. Apparently the Datura follows too closely the pig, the cow and the plough of man. The taxonomist believes further that the characters shuffled so glibly by the geneticist are of trivial significance, with little or no influence upon survival in nature; and that taxonomic recognition of such genetic characters would render classification of plants and animals an impossibly unwieldy task.

The geneticist believes that the mere classification of the plants and animals of the world has reached the point of diminishing returns; that a "species new to science" has even less interest than the discovery of a new gene, since the latter may be put to work as a tester in helping to solve some of the problems in nature, while the new species may only help to swell the size of our taxonomic card catalogue. The geneticist accuses the taxonomist, among other faults, of lacking interest in the evolution of the forms he studies and of using trivial traits in his classification, which often shows little superiority to the Linnean system, so far as bringing out evolutionary relationships is concerned. The taxonomist is also accused of not caring whether the effects which he classifies are primarily genetic or primarily modifications brought about by the environment. In other words, the taxonomist is felt to lack both the evolutionary and the genetic view-points. These complaints from the two fields are admittedly extreme and only partially justified. It is a matter of congratulation that the fence between them has begun to be broken down in places. Taxonomists are known who have brought under cultivation the plants they were monographing, albeit not with the entire approval of their taxonomic colleagues. And geneticists have been known to study in nature the species with which they were carrying on genetic experiments and have even consulted the dead specimens in a herbarium.

Let us compare for a moment the effects of the view-points of evolution and of genetics upon the average individual, our much-quoted friend, the man in the street. The opposition of the public to evolution was immediate, violent, and the end is not yet. It would seem that the evolutionary view-point had deeply stirred our friend in the street. An analysis of the situation renders it evident that there is no natural opposition to the evolutionary view-point as such. The agitation which the theory has aroused was due almost entirely to its indirect effect upon established dogma of theology. Any other theory equally powerful in undermining the bulwarks of a mechanistic creed would have aroused as much opposition. That man has consanguinity with lower animals is not inherently abhorrent to the human mind as shown by the oriental belief of millions of people in the transmigration of souls and by the gods represented in Egyptian mythology as half animal in form. Man is most intently interested in the things of the present and the immediate future. In the year 1931 we can find plenty of men who would be willing to fight for their own wives and even some who would fight for other men's wives, but we would have difficulty in

finding a man so far visioned as to be willing to fight for the wife of an ancestor a thousand centuries ago or for the wife of a descendant a thousand centuries to come.

Our friend in the street might still believe that the first man was constructed from the dust of the ground or he might have been led to accept evolution. In the latter case he might believe with Gregory that man descended from an ape-like ancestor who cavorted only in trees, or he might prefer Osborn's doctrine that man arose from a similar ancestor with another name, who ran flat-footed on the desert sands. But his acceptance of the evolutionary view-point in itself would not materially alter his philosophy of every-day life. The genetic view-point offers a contrast to the view-point of evolution. Its central idea—Mendelism—was fathered by a monk without opposition from the church. Its growth to the present day has not engendered distrust or conflict in the public mind. And yet the genetic view-point has in it the power to change the attitude of our friend in the street in regard to well-nigh all his human relations.

Now what are the attitudes of mind which the genetic view-point is capable of changing? They are for the most part ingrained beliefs or assumptions which unconsciously color one's thinking. An example may be taken from a patriotic document familiar to every schoolboy. The Declaration of Independence says, "We hold these truths to be self-evident, that all men are created equal." This proposition, like many others assumed to be self-evident, is certainly not true. Despite what biology has taught us in the 150 years and more since the Declaration of Independence, its statement regarding the equality of all men at birth is probably an unconscious assumption in the minds of the majority of mankind, at least in regard to various aspects of man's nature. If questioned, our friend in the street might admit that the child of Japanese parents would probably not have the same stature and complexion as American children. And yet he probably would assume that, could we equalize the differences in education and other environmental influences to which any two children of a given race were subjected, the performance of the two children would be alike.

Those with genetic training may find it hard to realize the prevalence of the belief that men are born with equal potentialities. And yet this belief is not confined to the scientific layman. It is found among trained scientists and even among those who have a high standing as investigators of biological problems. In a review of a recent book on behaviorism, the New York *Times* quotes J. B. Watson as saying, "I would feel perfectly confident in the ultimately favorable outcome of careful upbringing of a healthy, well-formed baby born of a long line of crooks, murderers and thieves and prostitutes. I should like to go one step further now and say, 'Give me a dozen healthy infants, well formed, and my own specified world to bring them up in and I will guarantee to take any one at random and train him to become any type of specialist I might select—doctor, lawyer, artist, merchant-chief and, yes, even beggar man and thief, regardless of his talents, penchants, tendencies, abilities, vocations and race of his ancestors.'"

Our quoted psychologist's declaration of independence of any genetic view-point is answered in a measure by critical experiments designed by another psychologist. The Seashore tests clearly show that humans do differ in their innate musical capacities and limitations. From our knowledge of genetics it is safe to say that in man no two individuals are exactly alike or ever have been; and, save for the possible exception of identical twins, probably no two individuals have ever been born with the same genetic constitution. Whatever politicians and others may say about the equality of mankind, the success of democracy is due to inequality, to leaders whom the majority learn to follow.

The genetic view-point regarding differences between individuals is opposed by current belief and by many tendencies in modern civilization. Uniformity seems to be the goal of conduct inculcated in the young. When young hopeful has shown a certain measure of originality in his behavior, grandmother is prone to lead him gently back to conformity with custom by the question, "Just think, little man, what would happen if everybody did as you have just done?" The logical reply would be, "What would happen if everyone were a grandmother?" Standardization has been a success in industry, but the genetic output of mankind—the production of children—will probably always remain a home industry rather than a matter of factory mass production. The products of this our literally infant industry need protection from the label of uniformity. Increased means of communication, movies and the radio, moreover, tend to make us look and act alike and are spoiling interesting experiments in different parts of the world in customs and ways of thinking.

An activity in which a thorough appreciation of the genetic view-point might materially alter present practice is our much-discussed educational system. Teachers expend their greatest efforts in attempting to raise low-grade students to average performance; but special capacities are inevitably pulled down toward mediocrity under a system in which uniformity is an unconscious ideal. From grades to graduate school, insufficient effort is directed toward discovering and developing exceptional talent. The road to a doctorate is prescribed and narrow. He

that attempteth to enter in by any other way, even though bearing ample fruits of scientific endeavor, is seldom rewarded. I have touched on these matters elsewhere. Suffice it to say that genetics teaches us the tremendous value of the exceptional individual in man as well as in economic plants and animals. How exceptional capacity may be early recognized and how it may be utilized in the furtherance of man's social and of his biologic evolution is a major problem of mankind which the genetic view-point has helped to emphasize.

The genetic view-point teaches that every biologic reaction is conditioned by the genetic constitution as well as by the external influences to which the individual is subjected. In other words, what every living being is and does is dependent upon the constantly interacting factors of heredity and environment. An appreciation of the relative value of these two factors would affect our ideals and practice in social and religious justice, in charity and education, and in all efforts for permanent human betterment. The genetic view-point attempts to evaluate the relative influence of heredity and environment but has been led by experience to look first for genetic causes of biological phenomena. Our friend on the street is prone to look first, if not exclusively, for environmental causes. The attitude of mind is seen in many biographies. The independent, self-reliant disposition of a national celebrity brought up in western pioneer surroundings, and the love of nature of a biologist raised in constant association with the wild life of the forests in Maine have been attributed to the direct effect of their environments. The fact that others in the same environment have not been similarly affected seems not to have been considered by the biographer, nor the possibility that the parents of their heroes may have been drawn to these environments by qualities of mind that have been transmitted to their offspring.

The blue grass region of Kentucky may grow taller men than other parts of the country, but their tallness in stature may have little to do with the blueness of the grass or other environmental peculiarities of the state. The real explanation may lie in the fact that the early settlers of this region came from the tallest racial stock in Europe, as Davenport has suggested. Anthropologists believe they have evidence that conditions in this country have increased stature and affected other anthropological measurements, thus bringing about changes in the physical nature of man in America. We have been told, for example, that less use of the jaws and muscles of mastication, due to better prepared food, is reducing the teeth, the jaws, the breadth, protrusion and massiveness of the face. Environment is known to have a direct influence upon individual development and thus might reasonably be expected to affect anthropological measurements. In such case, however, the effects would hardly be expected to be cumulative. The differences observed may conceivably be due to differences in genetic constitution between the two groups measured. The human species is tremendously heterogeneous even within a so-called race and it would be extremely difficult to be sure of securing two samples in which the differences in genetic constitution would be negligible, especially if the samples came from different countries or from different generations. In the latter case, age differences might be a source of error. In both cases a geneticist could think of possible genetic explanations. The genetic view-point would urge caution, therefore, in seeking first an environmental explanation for anthropological differences. Similar suggestions might be offered regarding most other phases of the study of man in which genetically controlled conditions are so difficult of attainment.

Twenty-five years ago I listened to a symposium before the British Association for the Advancement of Science, in which it was debated whether chromosomes had any connection with heredity. The passage of time has settled the question. A mechanism of heredity involving the chromosomes has been established; and the conclusion seems amply justified that any changes must be gotten into the chromosomes in order to be inherited. The genetic view-point, therefore, would place the burden of proof upon those who ignore the known mechanism in their attempts to influence the hereditary stream.

The belief is common, in one form or another, that an environmental stimulus is capable of calling forth an hereditary response similar to the original stimulus applied. A pregnant mother is chased by a turkey gobbler and her child is born with a red birthmark on the throat. The blemish is diagnosed as a result of maternal impressions. Beliefs such as this, which run counter to the established mechanisms of heredity, are called superstition if held by the man in the street. If held by a biologist, they are often called Lamarckism. In both cases they indicate an ignorance or neglect of established mechanisms.

The expectation that induced changes should resemble the stimuli which initiated them is *a priori* improbable and opposed to the known cases of induced mutations. Much of the belief in the inheritance of so-called "acquired characters" is the result of wishful thinking. One who believes, for example, that a man's college education will affect the mind of his newly born children may be led to realize that it is capacity to respond, and not the response itself, which is inherited. One who believes he has an example of environmentally induced somatic modifications affecting the germ-plasm should be forced to

prove that new factors for these changes have been gotten into the chromosomes. No such proof has yet been given for the inheritance of an "acquired character."

The pigmentation of races in the tropics, for example, has been considered an "acquired character" induced by the intense illumination, which has become inherited as a racial characteristic of tropical peoples. The differences in types of pigmentation in different races of man might have made a cautious student hesitant to propose the above explanation. Similar differences in pigmentation are found in man's nearest relatives, the anthropoid apes. Thus the chimpanzee has a pale skin and the gorilla has a black or negroid skin. Both live in the forests of equatorial Africa. Furthermore, pale pigmentation might even better be regarded as the more recent type, since dark skin pigment, at least that of the Negro, does not behave as a recessive character and recessives, so far as our experience goes, are more likely to be derived types. There is no critical evidence in support of the belief that the pigmentation of races is an example of the inheritance of an acquired character.

The evident adaptations of species to their surroundings naturally lead to the belief that in some way the environment has had a directive influence. Whether this has involved more than the elimination of the unadapted through natural selection is still an open question. But the rôle of natural selection still remains a major problem awaiting adequate experimental investigation. Experimentation has given us a mechanism of inheritance. Is it too much to hope that experimentation can give us also the mechanisms of evolution? Genetics has been largely confined to a study of inheritance. The origin of the term admits of a broader definition. The future geneticist may concern himself more with the problems of evolution. Evolution then may properly be considered a subdivision of genetics.

The mechanism of Mendelian inheritance, with unit factors dealt out to us by chance, may be an unpleasant idea to some. But whether we like it or not, it is an idea which is influencing our views of life. Responsibility and freedom of will, for example, have been much argued in the past. In future discussions of these subjects, philosophers must take into account the mechanism of inheritance.

You may be wondering why in such an assemblage as this I have been discussing the biological sins in attitude of the man in the street. My reason is that, so far as the genetic view-point is concerned, the man in the street is often a biologist. By biologist I mean one engaged in the study of any form of life, especially in this case including man. It has seemed less personal to discuss the man in the street, although beliefs differing only in form are held by our non-genetic brethren in biology.

Perhaps the most common evidence of lack of genetic view-point among biologists is shown in their use of biological controls. Many fail to realize that plants and animals which look alike may differ markedly in genetic constitution and hence in their individual response to selected stimuli. To take examples from our own experience, Miss Satina has shown that races of bread moulds (Mucors) which are indistinguishable in appearance, even when examined microscopically, may differ in sex, strength of sexual activity and in their biochemical reactions.

In the jimson weed we have what we call cryptic races. They resemble our standard line in all visible particulars, and even an examination of their chromosomes might reveal no differences. That they are unlike our normals, however, is shown, first, by the peculiarities in inheritance of certain genes, but only in plants with particular chromosomes extra; second, by modification of the morphology of certain extra chromosomal types when hybridized with them; third, by abnormal configurations of chromosomes (circles of four instead of pairs) in hybrids with normals; and also by other peculiarities of behavior under special conditions. Before the existence of these cryptic types was suspected, it was felt desirable to establish a purified race as a standard. We now have such a race, the result of 17 generations of selfing and once passing through a haploid. All our primary and secondary extra chromosomal types have been gotten into this standard line, and their peculiarities can now be compared without the haunting fear that other factors than extra chromosomes may be influencing their behavior. Our own results, therefore, are closely comparable among themselves. The results might not be comparable, however, if experiments were carried on with races from different countries even if these races were highly inbred. We now know enough of the distribution of cryptic types in nature to be practically certain that an investigator of wild strains of Datura from Europe would be unable to duplicate all the results obtained from our standard line of this species.

Comparable living material is as important to the biologist for accurate experimentation as is purified chemical material to the chemist. Species in nature or commercial varieties when subjected to careful analysis have been found to be a mixture of diverse races, or otherwise genetically heterogeneous. Many investigators without genetic experience, however, are satisfied with sunflowers grown from a packet of commercial seed or with guinea-pigs purchased from the trade for their biological material, although they may be insistent upon the purity of their chemical reagents. Such too common failure to realize that the

living reagents may differ in their physiological responses has often led to conflicting results of different investigators, as well as of a single investigator, when working with the same species.

When results are easily evaluated, over-refinement in an experiment may be a waste of time, but it is well to recognize the sources of error before making short cuts in methods. It will probably be safer in starting an elaborate experiment to use pure chemicals and comparable biological material.

In plants, genetically comparable material may be secured by using cuttings of a single individual, or relatively pure races may be obtained by selfing for a few generations. With animals having biparental reproduction, purification of races is difficult. By continued brother to sister matings, however, strains can be isolated incomparably better adapted to experimental purposes than the ordinary run of laboratory animals. Such inbreeding of mice, for example, has led to the isolation of races differing markedly in susceptibility to inoculated and to spontaneous tumors. Medical investigators as a class seem only just beginning to realize the value of the genetic view-point. Perhaps of more value to the medical profession than another endowment for cancer research would be an international institute for the breeding of purified races of rats, mice, guinea-pigs and other biological test material. Investigators in different parts of the world might then have available a source of comparable living reagents.

In man, our worst experimental animal, such purification is impractical. Identical twins we have suggested as the only source of really comparable material in the human race, but their use for experiments is limited. In human experiments, in which controls are most needed, it is most difficult to get comparable material. In human problems, therefore, dependence is unavoidedly placed upon the dangerous methods of random sampling and statistical treatment and conclusions are often drawn from data which, with forms better adapted to experimentation, would be considered inadequate. It should not be forgotten, however, that the mathematical reliability of conclusions bears no relation to the difficulty in securing adequate data.

We have given an all too inadequate presentation of the need of the genetic view-point in the street and in the biological laboratory, and have pointed out how common has been its lack even in high places. We have reached the point in our discussion at which to inquire what we are going to do about it.

In research, a blending of view-points in cooperative investigations suggests itself as a remedy. The geneticist may find he receives more than he contributes in such cooperation.

For the oncoming generation we can strive to strengthen the genetic education. It seems difficult for one to come to think in terms of the genetic view-point without actually following the shuffling of genes in breeding experiments. We may not succeed in convincing our educational administrators that laboratory work is as much needed in genetics as in chemistry. We can at any rate encourage the growing of Drosophila and to this end might bring political pressure to bear to lower the duty on bananas.

In stressing the shortcomings in other fields of labor, my voice may sound like the voice of a preacher. I have tried, however, to follow the lines of least resistance and at the same time of greatest efficiency. We know more about the faults of others than of ourselves. If we were able to view ourselves from a distance and there were unlimited time, we might relate some of our own sins and give advice to geneticists. The pleasure of giving advice to geneticists, however, can more profitably be left to a later speaker who is not a geneticist. Advice, you know, is a commodity which it is more blessed to give than to receive.

In conclusion, we feel justified in believing the genetic view-point, with all that it implies, is the most important biological contribution of the nineteenth and twentieth centuries. It is still broadening its scope and influence, but even now it has within it the power to change profoundly our philosophy of everyday life. In any program for the salvation of the future of the human race, it will be necessary to have the genetic view-point somewhere in the formula.

AN OPTIMISTIC VIEW OF THE EVOLUTION OF THE SCIENCES[1]

By Dr. VIRGIL F. PAYNE
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THE American Association for the Advancement of Science has fifteen sections devoted to the activities of specific science or related groups. Science has been defined as accumulated and accepted knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws. In this sense a specific science is any

[1] Address of the president of the Kentucky Academy of Science read on April 3 at a joint meeting of the Ohio, Indiana and Kentucky Academies.

branch or department of systematized knowledge considered as a distinct field of investigation or object of study. If we accept this definition the fifteen sections are in reality science sections. In fact, standard dictionaries define all the fields of knowledge represented as sciences except history, and the association itself has designated section "L," historical and philological sciences. This broad view of science and the sciences is the one accepted for the present purpose.

While many fields of knowledge are accepted as sciences, only physics, chemistry, biology, psychology, sociology and economics will be taken as illustrations. For our purpose physics is defined as that branch of science dealing with those phenomena of inanimate matter involving no change in chemical composition. From the view-point of the complexity of original subject-matter physics may be considered the simplest of the sciences mentioned. No doubt, due to this simplicity and the availability of its materials, physics was one of the first bodies of knowledge to be accepted as a science.

Chemistry is defined as the science that treats of the composition of substances, and the transformations which they undergo. Since chemistry involves transformations in the inanimate matter of physics, it is to that extent a more involved science. It was as a consequence accepted later as a field of knowledge worthy of the efforts of scholars and as a suitable subject for students. In the sense that art relates to something to be done in contrast to science as something to be known, the art period of alchemy made its contribution to modern chemistry. Likewise the periods of iatrochemistry and of phlogiston made contributions. However, we trace our modern chemistry back more definitely to the work of Lavoisier.

Biology is the science of life; the branch of knowledge which treats of organisms. As such, biology involves more intricate and elusive subject-matter than do physics and chemistry. On account of the difficulties involved in establishing controls and in accumulating tested knowledge the workers in the simpler sciences are prone at times to deny the biologist unqualified admission to the science fraternity. The value of biology and the perseverance and caution of its workers have, however, long since resulted in the establishment of a science of biology with its various branches.

Psychology is the science of mind; systematic knowledge and investigation of the genesis, powers and functions of mind. Just as biology is considered more involved than physics or chemistry so in turn psychology in its pursuit of knowledge of the consciousness of life has had more difficulty in finding its place as a science. The techniques involved in the study of psychology differ so markedly from those associated with the measuring instruments of physics, the balance in chemistry, and the microscope in biology that we should not be surprised. The fact that the psychologists are so divided by their theories has been a factor in their tardy acceptance. In spite of the reluctance of the older sciences, psychology has now been generally accepted.

Sociology is defined as the science of the constitution, phenomena and development of society. Sociology involves the complexities of life and consciousness with all the added difficulties in adjustment attending the interplay of conscious life in groups of various sizes. Many thinkers maintain that sociology can never be a science but since the time of Comte the claim for this right has made progress. The greatest difficulty individual scientists have is in the recognition of the worth of techniques of scientists in other fields. The statistical method of sociology with its use of the expression, probability, is almost too much for the older sciences.

Economics is the science that investigates the conditions and laws affecting the production, distribution, and consumption of wealth. This science is included not so much because of a logical place in the order of complexity of the other sciences named but more on account of its timely interest. We may judge from the present condition of the world that there is no true science of economics or that the best economists are not trusted and such scientific knowledge as exists is not practiced. This conclusion is obvious in spite of the slowly accumulated and tested knowledge since the writings of Adam Smith in 1776.

It is difficult to divide the sciences into sub-groups. We may call physics and chemistry physical sciences, and the others considered biological and social sciences. For the present purpose the older and more commonly accepted sciences of physics, chemistry and biology will be referred to as exact or material sciences, and, the newer and more reluctantly accepted, psychology, sociology and economics will be referred to as social sciences.

A mixture of extravagant praise and equally bitter condemnation has been heaped upon these and other material sciences. These sciences have been commended as making possible the material advantages of our present civilization. They have been blamed for contributing to an increasing disregard for the accepted social values. This machine age has had to face the anomalous charge of bringing hunger to many because of an over-production of food and of depriving many people of the very benefits of the age because too many of these benefits had been produced. It seems only fair to assume that the material sciences have been working effectively and have the power to do much more. They have indeed made possible our material civilization and, in fact, also

they make possible the very best social civilization. By them all the necessities and the luxuries are produced with an average individual expenditure of time that allows leisure for transforming the social studies into real sciences.

Our hope then seems to lie not in decreased interest in the material sciences but in using the leisure afforded by them in perfecting the social sciences. We now have much more tested knowledge in psychology, sociology and economics than we are using. We may reasonably hope that intensive, continued research in these fields, equivalent to that given in the past to the material sciences, may produce comparable results. Confidence in the work of the social scientists should result in the establishment of a social order respected and observed by an improved race of people. The economist and sociologist may expect to assume the burden of so organizing society that it would be impossible for over-production and want to exist simultaneously on the earth. Under such an economic and social system everyone may be profitably engaged as producer, investigator or subject of investigation. In our present system a severe migraine headache has qualified one man for profitable employment as a research subject. The social scientists are ready to assume their responsibilities and the next step is to train a generation that will turn as readily to them for guidance in these fields as the present generation depends on the physicist, the chemist and the biologist. Because of the sobering influence of such a responsibility we need have little fear of extravagance of promise or action.

The accepted sciences may do well to drop their double standard of viewing one group of sciences as exact and another as inexact. They should lead in the unqualified acceptance and encouragement of the social sciences. The physicist and chemist deal with 25,000,000,000,000,000,000 molecules per cubic centimeter of gas or 33,667,000,000,000,000,000,000 molecules of water per cubic centimeter. They do not face all the hazards the sociologist encounters in individual differences of human beings in a small community. The physicist and chemist, in particular, should be very tolerant of the efforts of the sociologist to determine the statistical significance of the different phenomena observed in small populations.

If our social order is to come under the dominant influence of science it seems worth while to consider what will happen to some of the arts that have concerned themselves with society. The oldest and most highly respected of these arts is religion. We have in this art to deal with elements of belief, faith and prejudice which seem diametrically opposed to the principles of caution, control and tests in science. However, in 1873 F. Max Muller had written an "Introduction to the Science of Religion." We may hope that religion may eventually be saved for a scientific age by the acceptance of the method of science.

What attitude are we to take concerning the conflicts of theories in the social sciences? We must follow the plan we have always used in the older sciences. The conflicts must serve as a stimulus to more intense and exhaustive research. The conflicting doctrines in science have almost invariably resulted in bitterness—also a great amount of experimental study. It is not possible to condemn too heartily the attitude of the chemist who would get the camel through the eye of the needle by dissolving him in nitric acid and then using a squirt gun.

Finally, a word of caution seems appropriate. Should we displace entirely an old established art such as religion because it involves some unscientific principles and practices? No more should we discard this art than that of pottery-making while we are developing a science of ceramics. The vessel of the pottery craftsman may be crude. It may contain unnecessary ingredients; some very valuable ingredients may have been omitted, but if it makes a satisfactory container it has served a useful purpose. Certainly if perishable and necessary goods are being produced the industry should not be closed over a long period for repairs and remodelling. It has long been held that religion is such an enterprise. Furthermore it is worth while to be reminded again that our oldest sciences such as chemistry and astronomy were preceded by the arts, alchemy and astrology. When we feel most certain that we have found the final solution we may well recall Oliver Cromwell's exhortation, "My brethren, by the bowels of Christ I beseech you, bethink you that you may be mistaken."

OBITUARY

RAOUL GAUTIER

PROFESSOR RAOUL GAUTIER died at his home in Geneva, Switzerland, on April 19, 1931. He was vice-president of the International Geodetic Association of the International Geodetic and Geophysical Union. At the end of 1927, when he retired from the position which he had so long filled as director of the Astronomical Observatory of Geneva, Switzerland, the Conseil d'Etat of the Canton of Geneva conferred on him the titles of honorary professor of the University of Geneva and of honorary director of the Observatory. Previous to his retirement he

had filled the chair of astronomy and meteorology of the faculty of sciences of the University of Geneva.

For many years Professor Gautier was a member of the permanent commission of the old International Geodetic Association, attended several of its triennial assemblies and took a prominent part in its affairs. When the world war began and little support was given to the association by its adhering members, Professor Gautier was largely instrumental in forming what was termed the "Association Géodesique reduite entre Etats Neutres" and served as its president for several years. It was mainly due to his foresight and scientific efforts that anything at all was accomplished in geodesy, in an international sense. Through his efforts the results obtained at the variation of latitude stations at Ukiah, California, Mizusawa, Japan, and Carloforte, Italy, were computed and made available for the use of astronomers. After the war, when the International Geodetic and Geophysical Union was created, he transferred to the section of geodesy (name changed in 1930 to International Geodetic Association) of that union the functions and property rights of the old association and of the reduced association which had functioned during the war. He later became vice-president of the section (association).

In addition to his other duties, Professor Gautier was for many years president of the Swiss Geodetic Commission. He was a powerful influence for several decades among geodesists of the world and they, as well as the astronomers, mourn his death. His keen intellect and scientific attainments aroused the admiration of all those who knew him, either personally or through correspondence, and his charming personality endeared him to his many friends.

His health had not been good for the last few years, especially since the death of Mme. Gautier on January 4, 1927. After his retirement, on December 31, 1927, he was not actively engaged on astronomical or geodetic work, but he maintained until the very last his strong interest in those matters, especially such as were of an international character. He made several trips to the south of France in search of health, but most of his time was spent in Geneva. Two sons and two daughters survive him: Colonel Paul Gautier, of Bogota, Colombia; M. Max Gautier, Mme. William E. Rappard and Mme. Marcel DuPasquier, of Geneva.

WILLIAM BOWIE

U. S. COAST AND GEODETIC SURVEY

WHITMAN HOWARD JORDAN

THE death of Dr. W. H. Jordan, director of the State Experiment Station at Geneva from 1896 to 1921, occurred at his home in Orono, Maine, on May 8, following a prolonged period of ill health. Born in Raymond, Maine, on October 27, 1851, Dr. Jordan received his early training at the University of Maine, graduating from that institution in 1875.

In 1878 he entered the employ of the Connecticut Agricultural Experiment Station as an assistant chemist, and from that date on his professional career and personal interests to the time of his death were intimately associated with experiment station work. He returned to Maine in 1879 to serve for one year as an instructor in chemistry, and then went to the Pennsylvania State College as professor of agricultural chemistry in the college and as agricultural chemist in the experiment station. While at State College he laid out a series of soil plats for experimental purposes, the fiftieth anniversary of which is to be celebrated in June, when Dr. Jordan was to have been the guest of honor.

In 1885 he was called back to Maine to become director of the Experiment Station at Orono, where he served for eleven years. In 1896 he entered upon his work at Geneva as director of the New York State Experiment Station where he was to serve for twenty-five years and to attain an international reputation as an investigator and administrator.

Dr. Jordan was the author of books on human and animal nutrition and of numerous experiment station publications and special articles. He was also an effective speaker, and while director of the Geneva Station was frequently called upon by farm organizations and others to address them on the work of the station and on other topics. His conception of the function of the experiment station as a research institution and his insistence that the station be allowed to perform its work unhampered has undoubtedly had a profound influence on the contributions that the station has made to the agriculture of the state.

A. A. HIMWICH

ON April 18th occurred the death, in New York City, of A. A. Himwich, M.D., at the age of sixty-nine years. Dr. Himwich was one of the most beloved of the Russian intelligentsia, coming here among the first of the great immigration of 1881.

Dr. Himwich was a physician of recognized ability and continued his medical work at Berlin with Professors Klemperer and Kraus. At New York University he received the B.S. degree in 1886; M.D. in 1887 and M.S. in 1891. There Dr. Himwich was a beloved student of Chancellor McCracken, Professor Stevenson and Professor Herring. Post-graduate work was continued at Columbia under Professors Woodward and Pupin and at the Johns Hopkins under Professors Mall, Osler and Martin.

Dr. Himwich was deeply interested in the later developments of mathematics and physics and particularly in relativity. He was a fellow of the American Association for the Advancement of Science, and

a member of many scientific organizations, including the American Mathematical Society and the American Medical Association. For thirty years he was a visiting physician of the Beth Israel Hospital, of which he was one of the founders; and also a founder, and later the director, of the Educational League where college courses were given to men and women. Dr. Himwich was known by men in many fields and was active in progressive movements.

Important work was done by him unostentatiously, quietly and modestly. He was an idealist and well-loved, shedding light in his path. He was unobtrusively learned and continually busy with his studies and researches. Though always surrounded by books, he never shut himself from life and was ever ready to take part in useful social endeavors. His wife and two sons survive him: Dr. Rose I. Himwich, Dr. Harold E. Himwich, associate professor of physiology at Yale University, and Mr. Alfred W. Himwich, a teacher in the New York Public Schools.

M. D.

RECENT DEATHS

DR. ALDRED SCOTT WARTHIN, since 1903 professor of pathology and director of the Pathological Laboratory at the University of Michigan, died suddenly on May 23, at the age of sixty-five years.

EDWARD DEAN ADAMS, in large measure responsible for the electrical installations at Niagara Falls and other engineering projects, active in engineering and scientific organizations, died on May 23, at the age of eighty-five years.

PROFESSOR A. ZIMMERMAN, for the past nine years instructor in the department of chemistry of the University of Kentucky, died on May 21, at the age of thirty-five years.

PROFESSOR ALFRED WEGENER, the German meteorological explorer, chief of the German Scientific Expedition exploring central Greenland, has been found frozen to death. Dr. Wegener was fifty years of age.

SCIENTIFIC EVENTS

THE THIRD INTERNATIONAL CONFERENCE ON BITUMINOUS COAL

AN impressive group of scientists from Europe will take part in the Third International Conference on Bituminous Coal which will be held at the Carnegie Institute of Technology, Pittsburgh, Pennsylvania, from November 16 to 21. Germany, England and France will send the largest delegations.

New developments in fuel technology and utilization will be explained and discussed by the foremost authorities. Those interested in coal research may hear such German authorities as Dr. Friedrich Bergius, of Heidelberg, whose process for the hydrogenation of coal has been purchased by the I. G. Farbenindustrie; Professor Franz Fischer, of the Kaiser-Wilhelm Institute for coal research, whose process for forming liquid hydrocarbons from gases has been widely discussed, and Professor Ernst Berl, of Darmstadt.

Among the English members, contributions will be made by Professor William A. Bone, of the Imperial College of Science and Technology, London; Dr. Cecil Lander, director of the Fuel Research Board, London, who has done much work on low temperature carbonization and the utilization of coal generally, and Dr. R. Lessing, consulting chemist, also of London.

France will be represented by a distinguished group. Among them will be Professors Mailhe and Camille Matignon, of the Sorbonne, Paris; M. André Kling, director of the Municipal Laboratory of Paris, who is known for his work in producing motor spirits from coal by hydrogenation. Other European nations will send their foremost scientists to the Pittsburgh congress.

The tentative program outlined by the conference committee places emphasis on the economic side of the coal industry. A discussion of the competition between coal, petroleum and natural gas will have an important place in the program. Recent large scale hydroelectric developments will come in for discussion when water power is compared with steam produced with coal as a source of energy. The future of coal as the source of power for locomotives and steamships will be forecast by scientific authorities in these fields. A report of the cost of transporting energy in various forms promises to bring forth a discussion on pipe lines for natural gas and petroleum, the coal car and superpower transmission.

Reports on the actual status of low temperature carbonization throughout the world have been planned for the third meeting. Other subjects that are sure to find a place on the program are the origin of coal, problems of combustion, gasification and liquefaction of coal, smoke elimination and preparation of coal for the market.

In preparing for the third international meeting, Dr. Thomas S. Baker, president of the Carnegie Institute of Technology and organizer of the congresses, spent several months in Europe, reviewing the coal situation. Invitations were extended at that time by Dr. Baker to a group of fuel technologists in addition to those named above, and a large attendance is assured.

In America a prominent group of men of affairs will assist with the conference. This group, the official advisory board, is composed of Mr. James A. Farrell, president of the United States Steel Corporation; Mr. John Hays Hammond, prominent mining engineer; Mr. Samuel Insull, public utilities magnate; Mr. Frank B. Jewett, president of the Bell Telephone Laboratories, Inc.; the Honorable A. W. Mellon, Secretary of the Treasury; Mr. F. A. Merrick, president of the Westinghouse Electric and Manufacturing Company; Mr. Auguste G. Pratt, president of the Babcock and Wilcox Company; Mr. H. B. Rust, president of the Koppers Company; Mr. Matthew S. Sloan, president of the New York Edison Company; Mr. Gerard Swope, president of the General Electric Company, and Mr. W. C. Teagle, president of the Standard Oil Company of New Jersey.

THE LABORATORY OF ANTHROPOLOGY AT SANTA FE, NEW MEXICO

AWARD of thirteen all-expense scholarships has been made for the Laboratory of Anthropology's third season of training in anthropologic field-method.

The scholarships are designed to enable properly qualified graduate students to supplement, by practical work in the field, the classroom and laboratory instruction which they receive at the universities. Recipients of scholarships take part in the current investigations of experienced research men; they have opportunity to become familiar with the use of modern field-methods for the collection of data; they gain experience in the interpretation of these data and in their application to anthropological problems, specific and general. It is planned to offer, year by year, scholarships for work in various branches of anthropology in various geographical areas.

Scholarships for this season have been awarded for training in archeology, under the direction of Dr. Frank H. H. Roberts, Jr., of the Bureau of American Ethnology, and will pursue field work in excavation and study of a Pueblo ruin near Houck, Arizona. Scholars in ethnology will work among the Mescalero-Apache of southeastern New Mexico, under the direction of Dr. Ruth F. Benedict, of Columbia University. Scholars in anthropology will work with Dr. Harry L. Shapiro, of the American Museum of Natural History, and will pursue their studies in a selected French-Canadian village.

The scholarships are open only to graduate students who are fitting themselves for professional careers in anthropology and who must be registered in university departments granting higher degrees in anthropology, and must be recommended for appointment by the chairman or head of the department in which they are registered.

The committee on scholarships received applications from forty graduate students who had been recommended for consideration by their departmental head. Awards for the nine week period of training during 1931 are as follows:

Physical Anthropology:

Carolyn M. Adler, Columbia University.
James M. Andrews, Harvard University.
Helen L. Dawson, Washington University (St. Louis).
Marcus S. Goldstein, George Washington University.

Alternates

Morris Titiev, Harvard University (first alternate).
William H. Sassaman, University of Chicago (second alternate).

Archeology:

Ralph D. Brown, University of Minnesota.
Solon T. Kimball, Harvard University.
Dale S. King, University of Denver.
Carl F. Miller, University of Arizona.

Alternates

Catherine L. Serrem, Radcliffe College (first alternate).
William J. Winter, University of Arizona (second alternate).

Ethnology:

Jules H. Blumensohn, Columbia University.
Regina Flannery, Catholic University, Washington, D. C.
John P. Gillin, Harvard University.
Morris E. Opler, University of Chicago.
Sol Tax, University of Wisconsin.

Alternates

Clarence W. Dupertuis, Harvard University (first alternate).
Rose Cantor, University of Pennsylvania (second alternate).

The members of the committee on scholarships are: Neil M. Judd, curator of American archeology, U. S. National Museum; A. M. Tozzer, professor of anthropology, Harvard University; E. Sapir, professor of anthropology and general linguistics, University of Chicago, *chairman.*

The Laboratory of Anthropology has been enabled to carry forth this field instruction in anthropologic field-method by reason of two grants in amount of $15,000 and $60,000, respectively, from the Rockefeller Foundation. These funds, with contributions from other sources, cover the expenses of such instruction from the period of commencement in 1929 to 1934 inclusive.

NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

THE second and final meeting of the Board of National Research Fellowships in the Biological Sciences for the award of 1931–32 appointments was held in

Washington on April 30 and May 1. In addition to the twelve reappointments and seventeen new appointments voted at the February meeting, seventeen further reappointments and twenty first appointments were made at the current meeting, as follows:

REAPPOINTMENTS

For domestic study: G. W. Beadle, agriculture; Ralph L. Beals, anthropology; P. J. Daughenbaugh, biochemistry; R. K. Enders, zoology; Paul E. Fields, psychology; F. L. Howard, botany; A. W. Kozelka, zoology; W. E. Lammerts, botany; C. E. Leese, zoology; R. B. Loucks, psychology; Helen Mar Miller, zoology; C. W. Watson, forestry; G. R. Wendt, psychology.

For study abroad: J. P. Greenstein, biochemistry; David B. Hand, biochemistry; C. H. McConnell, zoology; C. V. Smythe, biochemistry.

NEW APPOINTMENTS

For domestic study: M. P. Backus, botany; Abram G. Bayroff, psychology; C. R. Carpenter, psychology; A. E. Clarke, agriculture; Kenneth D. Doak, agriculture; C. R. Garvey, psychology; W. F. Hahnert, zoology; A. Hollander, biochemistry; T. L. Jahn, zoology; Barbara McClintock, botany; Florence E. Meier, botany; W. O. Nelson, zoology; Donald M. Purdy, psychology; A. E. Saeger, botany; Burch H. Schneider, agriculture; George D. Snell, zoology; J. M. Valentine, zoology; J. Volkmann, psychology.

For study abroad: Marc A. Graubard, zoology; E. L. Proebsting, agriculture.

In accordance with the plan of rotation in membership of the board the terms of the following members expire on June 30 of this year: H. H. Bartlett, botany; F. R. Lillie, zoology, and E. L. Thorndike, psychology. To complete the membership in these three fields, the National Research Council has appointed E. W. Sinnott, of Columbia University, for botany; M. H. Jacobs, of the University of Pennsylvania, for zoology, and Madison Bentley, of Cornell University, for psychology.

Meetings for 1932–33 awards will be held approximately early in February and either in April or May of next year. More definite announcement concerning these will be made in SCIENCE in the fall. Information and application forms may be obtained at any time from the Secretary, Board of National Research Fellowships in the Biological Sciences, National Research Council, Washington, D. C.

FRANK R. LILLIE, *Chairman*
Board of National Research Fellowships in the Biological Sciences

THE DIAMOND JUBILEE OF THE ST. LOUIS ACADEMY OF SCIENCE

THE St. Louis Academy of Science celebrated on April 14 and 15 the diamond jubilee of its foundation. The event was featured by a lecture delivered on April 14 by Dr. Robert G. Aitken, director of the Lick Observatory, who described some of the recent advances in astronomy. On the following evening the jubilee dinner was held.

The academy, which has lately been affiliated with the American Association for the Advancement of Science, was founded on March 10, 1856, under the presidency of George Engelmann, the well-known botanist. Its purpose was the practice and encouragement of research in various branches of science, the building up of a scientific library and the formation of a museum. From the beginning it formed a forum for the presentation and subsequent publication of researches in botany, geology, natural history, physics, chemistry, etc. Many of the original papers of George Engelmann, Hiram A. Prout, Benjamin F. Shumard, George S. Swallow, F. E. Nipher and William Trelease are found in the twenty-six volumes of the *Proceedings* which have been published. The academy maintains exchanges with a large number of the learned academies and societies of Europe and America.

Some of the present officers of the academy are Dr. Alfred F. Satterthwait, of the U. S. Bureau of Entomology, *president;* Dean Walter E. McCourt and John J. Lichter, *vice-presidents;* Dean Alexander S. Langsdorf, of Washington University, *recording secretary;* James I. Shannon, St. Louis University, *corresponding secretary;* Albert Kuntz, St. Louis University, *librarian,* and J. D. Robertson, *treasurer.*

THE AMERICAN ACADEMY OF ARTS AND SCIENCES

AT the annual meeting of the American Academy of Arts and Sciences, held at 28 Newbury Street, Boston, on May 13, the following fellows were elected in the scientific classes:

CLASS I

Mathematical and Physical Sciences

Charles Harold Berry, Harvard University.
Karl Taylor Compton, the Massachusetts Institute of Technology.
George Russell Harrison, the Massachusetts Institute of Technology.
George Leonard Hosmer, the Massachusetts Institute of Technology.
Robert Bruce Lindsay, Brown University.
William Albert Noyes, Jr., Brown University.
Otto Oldenberg, Harvard University.
George Rutledge, the Massachusetts Institute of Technology.

CLASS II

Natural and Physiological Sciences

George Blumer, Yale University.
William Bosworth Castle, Harvard Medical School.

Eugene Floyd Du Bois, Cornell Medical College.
William King Gregory, the American Museum of Natural History.
George Francis McEwen, the Scripps Institution, La Jolla, California.
Charles Alfred Weatherby, the Gray Herbarium, Harvard University.

Foreign Honorary Members

Ludwig Diels, Berlin.
August Krogh, Copenhagen.
Karl Willy Wagner, Berlin.

The following officers of the academy were elected:

President, Jeremiah D. M. Ford.
Vice-president for Class I, Harry M. Goodwin.
Vice-president for Class II, Walter B. Cannon.
Vice-president for Class III, Edwin F. Gay.
Vice-president for Class IV, Charles B. Gulick.
Corresponding Secretary, Tenney L. Davis.
Recording Secretary, Walter E. Clark.
Treasurer, Ingersoll Bowditch.
Librarian, Alfred C. Lane.
Editor, Herbert V. Neal.

On the recommendation of the Rumford Committee, the academy voted to award the Rumford Medals to Dr. Karl T. Compton, for his researches in thermionics and spectroscopy.

SCIENTIFIC NOTES AND NEWS

AT a dinner given by the Wistar Institute of Anatomy at the Hotel Bellevue-Stratford, Philadelphia, Dr. Simon H. Gage, emeritus professor of histology and embryology at Cornell University, was the guest of honor, on the occasion of his eightieth birthday on May 20.

DR. HARLOW SHAPLEY, director of the Harvard College Observatory, has been elected an honorary foreign member of the Royal Swedish Physiographic Society of Lund, and a foreign correspondent of the Royal Lombard Institute of Science and Letters.

DR. ALEXANDER WETMORE, assistant secretary of the Smithsonian Institution, has been elected an honorary member of the Société Orthologique et Mammalogique de France.

PROFESSOR ALBERT EINSTEIN, preliminary to delivering the third and last of his series of Rhodes Memorial Lectures at the University of Oxford on May 23, received from the university the degree of doctor of science.

THE University of Belfast will confer the honorary doctorate of science on Dr. Joseph Barcroft, professor of physiology at the University of Cambridge.

THE doctorate of laws was conferred by Queen's University, Canada, on May 6, on Dr. H. T. Güssow, Dominion botanist and chief of the Phytopathological Service of the Dominion of Canada. Dr. Güssow has also been elected a fellow of the Royal Society of Canada.

DR. PAUL ANDERSON, dean of the School of Engineering of the University of Kentucky, was the guest of honor at the annual spring dinner of the Kentucky Society in New York.

DR. CHARLES LANE POOR will retire from the chair of celestial mechanics at Columbia University at the close of the academic year. Dr. Poor's permanent address will be Dering Harbor, Greenport, Maine.

DR. MAURICE B. VISSCHER, professor of physiology and pharmacology at the University of Southern California, has been appointed professor of physiology at the University of Illinois College of Medicine in Chicago. He will occupy the chair formerly held by the late Professor George P. Dreyer. The new laboratories for physiology will be ready for occupancy during the summer.

DR. BORIS A. BAKHMETEFF, who was undersecretary of state and later ambassador to the United States during the Kerensky régime in Russia, has been appointed professor of civil engineering at Columbia University. He has been a consulting engineer in New York since 1922.

DR. RALPH D. BENNETT, who for the past year has been assisting Professor Arthur H. Compton in preparing for a series of experiments on cosmic rays, has been appointed associate professor of electrical engineering at the Massachusetts Institute of Technology.

DR. LOUIS B. SLICHTER has been appointed associate professor in the department of geology at the Massachusetts Institute of Technology. Dr. Slichter is a graduate of the University of Wisconsin, where he received the degree of doctor of philosophy in mathematical physics. During the war, he carried on research on the detection of submarines, and later formed, together with Dr. Max Mason, now president of the Rockefeller Foundation, a geophysical prospecting company for the location of mineral deposits. During the past year he has been engaged in the mathematical study of scientific geophysical problems at the California Institute of Technology.

PROFESSOR HENRI FEHR, head of the department of mathematics at the University of Geneva, has been appointed rector of the university. He is known to Americans and to the mathematical and educational world at large as the editor of *l'Enseignement Mathématique,* and as secretary of the International Commission on the Teaching of Mathematics, not only the present one, but the one that was founded in 1908. He has held a professorship in the University of Geneva since 1900 and was twice dean of the faculty of science.

DR. ERNEST WILLIAM HOBSON, since 1910 Sadlerian professor of pure mathematics at the University of Cambridge, will retire on September 3.

PROFESSOR KURT WEGENER, formerly head of the Spitzbergen Observatory, will succeed as leader of the German Scientific Expedition his brother, Professor Alfred Wegener, who died in Greenland.

DR. R. F. MEHL, superintendent of the division of physical metallurgy of the Naval Research Laboratory, has been appointed assistant director of research of the American Rolling Mill Company, Middletown, Ohio. He will be in charge of the physical science department of the Armco laboratories, and will take up his new responsibilities on September 1. He has been one of the research consultants for this company for the past eighteen months.

EARLY in May Dr. William Beebe sailed for Bermuda with a staff of nine. This will be the fourteenth expedition of the department of tropical research of the New York Zoological Society and the third Bermuda Oceanographic Expedition. Study of the fish of the shallow waters and deep sea trawling will be carried on from Nonsuch Island as a base along the lines of work of the last two years. Particular attention will be paid to the bottom fauna a mile and a half down. An attempt will be made in September in the bathysphere to reach a depth of half a mile beneath the surface.

DR. ROBERT HEGNER, professor of protozoology in the Johns Hopkins University School of Hygiene and Public Health, accompanied by two of his students, Dr. Carl Johnsen and Dr. Robert Stabler, sailed recently for Panama where they will spend the summer studying Amoebiasis at the Gorgas Memorial Laboratory.

THE American research expedition headed by Professor George G. Simpson arrived in Buenos Aires on May 20 from Patagonia after seven months' study of paleontological fauna on behalf of the American Museum of Natural History. Professor Simpson will continue his studies in the La Plata Museum.

DEAN RICHARD G. TYLER, of the College of Engineering at the University of Washington, will spend the coming summer in Europe, where he will inspect hydraulic laboratory installations in Germany and England. Dean Tyler, whose particular field is sanitary engineering, will also study water purification methods being developed by continental engineers.

THROUGH a cooperative arrangement between the Physikalische-Technische Reichsanstalt and the U. S. Bureau of Standards, an exchange of personnel has been arranged for the purpose of promoting work on fundamental standards. Dr. F. Henning, of the Physikalische-Technische Reichsanstalt, is studying at the Bureau of Standards the proposal of the bureau that the emission from a black body at the freezing point of platinum be adopted as the primary standard of light. Dr. G. W. Vinal, of the staff of the Bureau of Standards, is proceeding to the Reichsanstalt to engage in intercomparisons of the national standards of electromotive force and in work on the improvement of standard cells.

DR. HEINRICH WIELAND, professor of organic chemistry at the Technical School at Munich, winner of the Nobel Prize in chemistry in 1930, was a recent lecturer at the University of Washington. Under the auspices of the Washington Chapter of Sigma Xi, Professor Wieland discussed recent researches in biological oxidations. He is touring the United States, accompanied by Mrs. Wieland.

DR. F. G. BANTING, head of the department of medical research in the Banting Institute of the University of Toronto, spoke to students and faculty members of the medical school of the University of Michigan on May 8 on "The History of Insulin."

PROFESSOR H. D. SMYTH, of Princeton University, spoke at the Bartol Laboratory of the Franklin Institute on April 22 on "The Band Spectrum of Carbon Dioxide."

DR. G. H. PARKER, director of the Zoological Laboratory of Harvard University, delivered the following series of lectures, during the week of May 4, at the University of Minnesota under the auspices of the department of zoology: "The Nervous System and Its Effectors," "Chromatophores and Other Effectors in Relation to Secretion." "The Significance of Secretion in Sense Organs and Central Nervous Organs," and "The Passage of Sperms and Eggs through the Oviducts of the Higher Vertebrates."

THE College of Medicine of the University of Illinois Chapter of Sigma Xi held a meeting for the initiation of new members on May 20. At this meeting Dr. F. R. Moulton, past national president and member of the National Executive Council, pre-

sented greetings from the national organization. Greetings from Northwestern Chapter were presented by Dr. F. D. Barker, *president* of the chapter, and from the University of Chicago Chapter by Dr. E. S. Bastin, *vice-president* of the chapter. The scientific discourse was given by Dr. O. F. Kampmeier on "The Origin and Development of the Human Thoracic Duct."

AT the annual meeting of the Boston Society of Natural History, held on May 6, the following officers were elected for 1931–1932: *President,* Charles H. Taylor; *Vice-presidents,* Nathaniel T. Kidder, Glover M. Allen and William M. Wheeler; *Secretary,* Clinton V. MacCoy; *Treasurer,* Augustus P. Loring, Jr.; *Trustees,* Thomas Barbour, Joseph A. Cushman, William L. W. Field, Laurence B. Fletcher, Frederic H. Kennard and John C. Phillips. At the same meeting the annual Walker Prizes in Natural History, offered for the best memoir on any subject in the field of general zoology, were awarded to Arthur Svihla, of the State College of Washington, for his memoir entitled "A Comparative Life History of the Mice of the Genus *Peromyscus,*" and to Mr. Tze-tuan Chen, of the University of Pennsylvania, for his memoir on the "Sympathetic Nervous System of an Annelid."

A MEETING of the Acoustical Society of America was held on May 4 and 5 in Camden, New Jersey, in the auditorium of the RCA Victor Company. At this meeting the following officers were elected for the new year: *President,* Dayton C. Miller, Case School of Applied Science; *Vice-president,* C. W. Hewlett, General Electric Company; *Secretary,* Wallace Waterfall, The Celotex Company, Chicago; *Treasurer,* E. E. Free, New York City; *Executive Council,* F. R. Watson, University of Illinois; G. W. Stewart, The State University of Iowa; Vern O. Knudsen, University of California at Los Angeles; E. W. Kellogg, RCA Victor Company, Inc., Camden, New Jersey, and H. D. Arnold, Bell Telephone Laboratories, New York City. The next meeting of the society is to be held on November 30 and December 1 in Cleveland, Ohio, at the Case School of Applied Science.

THE fourteenth annual meeting of the Royal Society of Canada was held from May 20 to 22. Dr. Charles Camsell, deputy minister of mines of the Dominion, delivered, as president of the society, an address on Canada's position in the mineral situation of the British Empire. Dr. J. S. Plaskett, director of the Dominion Astrophysical Observatory at Victoria, British Columbia, gave a popular lecture on "The Structure and Motions of the Galaxy."

IT is stated in *Nature* that at the annual election of the Royal Philosophical Society of Glasgow, on March 25, the following officers were elected; *President,* Professor W. R. Scott; *Vice-president,* Dr. J. W. French; *Honorary Treasurer,* Sir John Mann; *Honorary Librarian,* Dr. J. Knight; *Honorary Auditors,* Mr. John J. D. Hourston and Mr. James A. French; *Acting Secretary,* Dr. James M. Macaulay. During the session, Sir Donald MacAlister, chancellor of the University of Glasgow; Sir C. V. Raman, professor of physics in the University of Calcutta, and Professor F. O. Bower, emeritus professor of botany in the University of Glasgow, were elected honorary members of the society.

A GENERAL meeting of the members of the Royal Institution was held on May 4, Sir Robert Robertson, treasurer and vice-president, in the chair. Sir Joseph Thomson was reelected honorary professor of natural philosophy, and Lord Rutherford of Nelson was reelected professor of natural philosophy.

IT is announced officially that the next International Mathematical Congress will be held the first week in September, 1932, at Zurich, Switzerland. The committee on organization consists of Professor A. Fueter, of the University of Zurich, *president;* Professors H. Fehr, rector of the University of Geneva, and M. Plancherel, of the Ecole polytechnique fédérale, Zurich, *vice-presidents;* and Professors F. Gonseth, of the Ecole polytechnique fédérale, and A. Speiser, of the University of Zurich, *secretaries.* The secretaries may be addressed at the Séminaire de mathématiques, Université, Zurich. It will be recalled that the first of these international mathematical congresses was held in Zurich in 1897.

THE Second General Assembly of the International Union for the Scientific Investigation of Population Problems will meet in London from June 15 to 19 of this year. The delegates of the American National Committee who will attend this meeting are: Dr. Raymond Pearl, president of the union, the Johns Hopkins University; Dr. Louis I. Dublin, chairman of the American National Committee, Metropolitan Life Insurance Company; Dr. Alfred J. Lotka, secretary-treasurer, American National Committee, Metropolitan Life Insurance Company; Dr. John Black, chairman, Commission 1, Population and Food Supply, Investigation of Population Problems of the International Union, Harvard University; Professor Robert E. Chaddock, Columbia University; Professor Henry Pratt Fairchild, New York University; Professor James W. Glover, president, Teachers Insurance and Annuity Plan; Dr. George W. Kosmak, editor, *American Journal of Obstetrics and Gynecology;* Mr. Frank W. Notestein, Milbank Memorial Fund; Dr. L. J. Reed, of the Johns Hopkins University, and Dr. P. K. Whelpton, of the Scripps Foun-

dation for Research in Population Problems. Seven of these delegates are sailing on the *Rotterdam* on June 6.

THE Paris correspondent of Science Service reports that the prize offered by the International Committee of the Red Cross at Geneva for a reagent to detect small amounts of deadly mustard gas in the air has not been awarded. The jury of chemists found none of the submitted reagents satisfactory. According to the terms of the contest, the reagent should have been able to detect with certainty less than one grain of the gas in about one quart of air. The amount of the prize was 10,000 Swiss francs, about $2,000. The contest closed last December and the jury has since then been considering the reagents submitted with their methods of use. These were known to the jury only by number, the names of the authors being kept separately. All the methods and reagents were examined in detail. Nine were eliminated at the first examination. The remaining four were made the subject of control experiments. The results were not sufficiently conclusive and the jury decided it could not award the prize offered by the committee. The jury consisted of the following: Professor G. Urbain, of the Sorbonne, director of the Chemical Institute of the University of Paris, president; Professor F. Haber, member of the Berlin Academy; Professor F. Swarts, of the University of Ghent, member of the Belgian Royal Academy of Sciences; Sir William Pope, professor at Cambridge University, member of the British Royal Society; Dr. H. Zangger, professor at the University of Zurich, director of the Institute of Legal Medicine of Zurich, and Professor Demolis, technical adviser of the International Committee of the Red Cross.

THE National Geographic Society has presented to the National Museum of Washington the zoological specimens collected by the expedition to the jungle frontier between Brazil and Venezuela which was headed by Mr. Ernest G. Holt.

THE Division of Horticultural Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, has established at Seattle, Washington, a laboratory to be devoted to research on the freezing preservation of fruits and vegetables.

THE economic depression has been reflected in the hospitals throughout the country, it appears from the American Medical Association's annual survey of hospital service in the United States, as quoted by Science Service. Although the hospitals did more work during 1930 than the previous year, the increase came entirely in charitable institutions. The association states in the current issue of its journal that "While governmental and other charitable hospitals were burdened with an unusually large number of patients, those that serve pay patients generally suffered a decrease in patronage." During 1930, the number of beds in all types of hospitals increased from 907,133 to 955,869. This increase of 48,736 beds does not include bassinets, of which there were 1,645 more during 1930 than the year before. Hospitals for nervous and mental patients continued to grow. The capacity of these institutions increased from 414,386 to 437,919. Over nine tenths of the beds available in these hospitals were occupied during 1930, while less than two thirds of the available beds in general hospitals were occupied. Outpatient services of hospitals had a tremendous growth, both in the number of such departments and in their use. The greatest number of new departments were organized in western states, but the greatest rate of growth was in the South Atlantic states. The type of service given in hospitals has also shown a steady improvement during recent years, as shown by the increased number of x-ray and physical therapy departments and laboratories.

DISCUSSION

THE PROGRAM OF THE UNIVERSITY ASSOCIATION FOR THE STUDY OF CALENDAR REFORM

THE University Association for the Study of Calendar Reform has been organized by a group who believe that any real alteration of the calendar is some years in the future, as only a small minority in scientific, educational and business circles is showing interest, and these persons do not agree on what alterations are desirable. The members of this association believe, therefore, that persons interested should investigate methods of eliminating as many as possible of the alleged defects of the present calendar without waiting for the proposed overhauling. In other words they suggest that we clear the ground for future work by finding out which of the troubles charged are real calendar defects, and which can be remedied by changing present methods.

According to calendar reform organizations (SCIENCE, January 30, 1931, page 118), "the three undisputed defects of the present calendar are: Unequal months; changing of week-day names for monthly dates; drifting dates for Easter and other church festivals." The months vary in length from twenty-eight to thirty-one days. The number of

working days is even more variable because of holidays and the five-Sunday and four-Sunday months, and in addition a correction for seasonal differences must be applied in business studies. The "changing of week-day names for monthly dates" means that business in months of one year can not be compared with that of corresponding months in the year following without corrections; and that a schedule of events made out for one year in month and day of month must be altered to fit the weeks of the following years. The present custom is to schedule recurring events as, for example, the Saturday following the fourth Monday of April; but in spite of much time spent in devising such rules, there are many conflicts, mistakes and worries. The other "undisputed defect" is a religious custom, not a calendar defect. The dates for these church festivals drift because they are not set by our present calendar. Easter commemorates the Resurrection of Jesus, and the Christian Church has seen fit to use, not only the date as given in the Scriptural narrative, but also the lunar months in use in Palestine at that time. Whether or not this rule is to be changed is a question for the churches to decide, and it should be discussed in religious, rather than scientific periodicals. Some wage earners who are paid weekly have difficulty meeting heavy monthly bills, and some persons on a monthly salary have trouble with weekly bills. Other difficulties have been charged against the calendar, but most are associated with the four we have listed.

Let us now consider, as we have suggested, the possibilities of improvement without waiting for an international overhauling of the world's calendar. First: For annually recurring events the period of recurrence is a year, and such events should, therefore, be assigned a certain week of the year, instead of a certain week of the month. The fifty-one (sometimes fifty-two) complete weeks of the year are indicated on calendars and almanacs in general use, and numbers for these weeks can easily be written on the margin of the office calendar. If the schedule for the following year is made out, assigning to each annually recurring event the same week and day of week as for this year, these events fall in exactly the same order, and the relation of each to all others in the annual schedule is unchanged. In this way a few interested business men can make out a permanent schedule for nearly all important events in their community without the average citizen knowing anything about it. Later, if a sufficient number become interested, calendars with the numbers for the weeks printed to the left of Sunday should be put in circulation. The general public probably would, at first, pay no more attention to these numbers than to those indicating the day of the year now printed on so many calendars; but the more intelligent would soon begin using them for such purposes as figuring the number of weeks for which wages must be paid on a certain job, or the number of weeks to the close of the school year. If the calendars carry the suggestion that the number for the week be used in scheduling recurring events, an increasing number of schedules would be so made out, and the date confusion to which calendar reformers refer would be practically eliminated. A business firm operating on this plan, which has been called the *numbered weeks* system, would, year after year, be scheduling practically the same events for a given week, and the sales for a group of weeks in one year could be directly compared with the same group in other years, thus avoiding another difficulty. Since many firms are now using an auxiliary calendar of groups of weeks to avoid the unequal months, the suggestion is evidently practical. Easter is a religious question, as we have pointed out, and need not be considered here. The last difficulty—that of wage earners on a weekly basis with heavy monthly expense items, is avoided by billing on each pay day, which is now recognized as a good business principle.

The preceding brief discussion has of necessity touched on only a few points, but we hope it has been sufficient to suggest the program, in line with the experimental method of modern science, which the organizers of the association now favor. The officers are: *Joint Chairmen,* Roy C. Flickinger, University of Iowa, Iowa City; Jakob Kunz, University of Illinois, Urbana, and *Secretary-Treasurer,* C. C. Wylie, University of Iowa, Iowa City. Correspondence is invited.

C. C. WYLIE

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PLURAL FRACTIONS AND OTHER FRACTIONS

UNDER the title of "Plural Fractions," Dr. C. E. Waters in the February 20 issue disapproves of the practice, common in scientific journals, of using the plural of the unit named when the number is a fraction; examples are .04 grams and .5 atmospheres. His arguments are good from his point of view, but there is another way of looking at the question.

Dr. Waters says that in reading 4/100 gram one naturally says "four one-hundredths (of a) gram," and he objects to writing .04 grams. But if instead of supplying *of a,* we supply *measured in,* then the plural is required. In a table headed "potential, volts" or "wave length, Angstroms," one naturally supplies *measured in* where the comma is placed, and when this is done the heading seems a perfectly natural one even though the maximum potential recorded be −.825 volts.

Probably no one will deny that it is more convenient to adopt the plural form exclusively for such writing, for one may then head a table "potential, volts" without committing an error when some of the figures are fractions or are negative. Another advantage is in the use of abbreviations; one may write *g* for *grams,* and not bother about *g* or *gm* for *gram* and *gs* or *gms* for *grams.* We should be pleased, then, if a justification has been found for the almost universal practice of using the plural form exclusively.

Dr. Waters objects to "occurs at every 2×10^3 collision" on the grounds that one would not write "at every two collision." Now we can easily write "at every second collision" or at "every fiftieth collision," because there is a well-known terminology for the small ordinal numbers, but for the large ones this is not true. Dr. Waters assumes that in this example 2×10^3 is used in its numeral sense: I prefer to take it in its ordinal sense. Should one write 7.2×10^8 *d* or 7.2×10^8 *th*? Either is awkward and apt to be misunderstood, so why not use 7.2×10^8 for either the ordinal or numeral sense when there can be no ambiguity? The same is being done with small numbers; we see a street sign marked "38 street" and read it "thirty-eighth street."

An offense worse than misusing singular and plural forms in naming units is not to use either one, so let us hope that no one will be so fearful of blundering in the singular and plural that he choose to omit any name whatever.

While on the subject of plurals I should like to mention the perplexing problem of forming the plural of symbols. In dealing with equations involving x_1, x_2, x_3, . . . , when one wishes to speak of them collectively, it is probably easy enough to write "the x_i's in eq. (3)," but if these quantities had been denoted by $A'_1{}^2$, $A'_2{}^2$, $A'_3{}^2$, . . . or some other complicated symbols, plurals formed with the apostrophe and *s* would be clumsy. A practice that seems proper, is surely advantageous and deserves wider use is to omit any sign of plural form and simply write "the x_i (or $A'_i{}^2$) in eq. (3)." Many nouns do not add *s* or change in any way in the plural, so there is nothing peculiar in mathematical symbols behaving the same way. In some foreign languages the modifying article is different in its singular and plural forms and the mathematical writer profits by it. In English it seems best to use the symbol without change in the collective sense, and charge the offense, if there be any, to the deficiencies of our language.

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THE ACCUMULATION OF STRONG ELECTROLYTES IN LIVING CELLS

RECENT uncritical discussion[1,2,3] of the relative validity of the two hypotheses as to the mechanism of selective accumulation of ions by living cells merits rectification. We refer to the "molecular hypothesis" (Osterhout) and the "ionic exchange" hypothesis (Brooks).[4,5,6] Osterhout's criticism of the ionic exchange hypothesis is self-contradictory, illogical, or based upon distorted interpretation, and he does not discuss certain serious weaknesses of his own molecular hypothesis.

Specific details being incompatible with the space limitations of the present communication, attention is called to the following condensed comparison.

(1) No test permitting *experimental* discrimination between the two hypotheses has yet been applied. Experimental alteration of intra- or extra-cellular pH does not constitute such a test. Disagreement between observed and calculated rates of ion intake when the basic assumptions are changed in the middle of the calculation (*i.e.,* after numerical values for relative permeability to different ions are reached) proves nothing as to the relative validity of the two sets of assumptions.

(2) No non-aqueous solvents[7] have to my knowledge been shown to be more permeable to KOH than to NaOH, as apparently demanded by Osterhout's molecular hypothesis. On the other hand, divers artificial and natural membranes which are selectively permeable to cations do show such a difference as regards K^+ and Na^+, and so do many if not most living cells. Analogous anion permeable membranes resemble living cells in showing little differential permeability to different univalent anions. The ionic exchange hypothesis thus has well-established experimental analogs, which are entirely lacking for the molecular hypothesis, which has so far offered no rational explanation for the highly selective absorption of ions by living cells.

(3) The molecular hypothesis fails to explain why K in the form of KCl molecules does not pass out of the cells used by Osterhout faster than it goes in as KOH. Using Osterhout's formulations we deduce as necessary to his hypothesis the following assumptions:

a. That KCl is about 50,000,000 times more disso-

[1] W. J. V. Osterhout, *Jour. Gen. Physiol.* 14: 277, 1930.

[2] W. J. V. Osterhout, *loc. cit.,* 14: 285, 1930.

[3] A. G. Jacques and W. J. V. Osterhout, *loc. cit.,* 14: 301, 1930.

[4] S. C. Brooks, *Proc. Soc. Exp. Biol. Med.,* 27: 75, 1929.

[5] S. C. Brooks, *Protoplasma,* 8: 389, 1929.

[6] S. C. Brooks, In *Contributions* to Marine Biology, Stanford University, California, 1930.

[7] Exception being made of selectivity ion-permeable membranes which may be regarded either as porous solids or as non-aqueous solvents (see Brooks[6]).

ciated in aqueous solution than is KOH, or

b. That the diffusion constant of KOH in the hypothetical non-aqueous medium bounding the protoplasm is 50,000,000 times that of KCl, or

c. That the two factors combined account for the 50,000,000-fold difference.

Such assumptions would be purely *ad hoc* and without experimental basis or parallel.

(4) Until 2 and 3 above are satisfactorily explained the molecular hypothesis must be regarded as untenable.

The detailed answer to Osterhout's criticism and a fuller explanation of the above points will be published in another journal.

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A CURIOUS COLOR PHENOMENON

WHILE experimenting with an intermittently flashing neon discharge tube, the writer observed a phenomenon which may thus far have escaped being reported, if not observed, by others. He has demonstrated it to a number of persons, all of whom agree upon the description of what they perceive. Whether the effect is subjective or objective is not definitely established, but it appears to be purely objective.

A neon tube about 4 meters long, made of 8 mm glass tubing, is bent in the shape of a grid, so that a rectangular area 25 x 35 cm is covered by the parallel portions of the tube, which are spaced about 2 cm between centers. The tube is supported in a frame-like box, backed by a reflector, and covered in front by a ground glass panel. The illumination from the tube is somewhat diffused, but the shape of the tube is distinguishable through the ground glass. The tube is flashed by the high voltage from the secondary of a transformer, giving about 10,000 volts maximum when a direct current through the primary circuit is interrupted. A mechanical device is employed to make and break the primary at any desired frequency up to twenty-five per second.

At the upper frequencies, the light appears nearly continuous, the color being that which has become so familiar through the neon advertising sign. As the frequency is gradually decreased, flickering becomes pronounced at about twenty flashes per second, without change in color. The duration of the flash is very short, but its time has not been determined. If the observer looks directly at the ground glass when the frequency reaches twelve or ten flashes per second, there appear around the edges of the screen bright fringes of color—blue, green, bright red and yellow—colors quite different from the normal color of the tube. The interplay of colors becomes more striking as the frequency is further decreased. They shift and dance about, and at a frequency of about seven they flash and flicker over the entire illuminated screen, with the regular neon color predominating as a background. The colors observed are vivid and unmistakable. At a frequency of three or four flashes per second the varying colors disappear and only the characteristic neon color remains.

If an electric fan is set in operation in front of the "neon screen," and the frequency of flashing adjusted so that there is apparently slow rotation of the fan, the edges of the blades are outlined with the "dancing" colors. The colors observed do not appear in the lines of the spectrum.

A neon tube bent in the form of a flat spiral, and without a ground glass diffusing screen, has been found to give similar effects.

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THE AUTO-TRACTION HYPOTHESIS OF CRUSTAL DYNAMICS AND MECHANICS

THE department of geology, University of Manitoba, has a paper in the press which presents a preliminary outline of an hypothesis of crustal dynamics and mechanics. It introduces the conception of a sheet-flow in the crust of the earth, similar to that in ice-sheets. It calls into play the translation of all available geological energy into the great forces that have effected the geological changes of the past and elucidates a mechanism that seems to throw new light on most of the major crustal phenomena.

The paper will be issued shortly in pamphlet form as a contribution from the department of geology, University of Manitoba, Winnipeg. Any one interested in the hypothesis may communicate with me at this address and a copy of the paper will be mailed as soon as it comes from the press.

J. S. DELURY

SCIENTIFIC BOOKS

Atlas Céleste. By E. DELPORTE. Cambridge University Press, London; Macmillan, New York, 1930.

LAST year Dr. Delporte, of the Royal Astronomical Observatory at Uccle, Belgium, set down new boundaries of the constellations as arcs of hour circles and parallels of declination. He did this work at the recommendation of the International Astronomical Union. Its successful completion was a remarkable example of international cooperation. This work

was accompanied by star charts on which the new boundaries were drawn.

It has been a happy idea to use these beautiful charts in the star atlas, which is the subject of the present review. The twenty-six charts covering the whole celestial sphere contain the stars brighter than magnitude 6.5. They are not overcrowded and the distinction between brighter and fainter stars is so well made that the appearance is unusually clear. The stars are drawn for equator and equinox of 1875.0 for the technical reason that the newly adopted boundaries were defined in this system. This led to the advantage that very little had to be changed in the southern hemisphere where Gould defined the boundaries.

The twenty-six charts are all printed on the right-hand pages. On the corresponding left-hand pages the positions of all stars, brighter than magnitude 4.5, are listed for 1875.0 and 1925.0. This feature makes it possible to obtain the positions at any other date with great ease. The magnitudes and spectral types of the stars are also given. On the same page we find separate lists of the more important variable stars, double stars, star clusters and nebulae.

The description of the boundaries is not given in this atlas. For these one has to use Dr. Delporte's "Délimitation Scientific des Constellations" or Professor Schlesinger's "Bright Star Catalogue." In an appendix to the latter the new boundaries are listed in a different way, which is at the same time simpler and more efficient

Dr. Delporte's "Star Atlas" is a useful guide at the telescope at a very moderate price. It is highly recommended to every student, amateur and professional astronomer.

The fact that the book has a French title ought not to frighten any one, as the text consists exclusively of astronomical symbols of an international character.

DIRK BROUWER

YALE UNIVERSITY OBSERVATORY

Lingnan Science Journal (continuation of *Lingnaam Agricultural Review*), Vol. VII and Nos. 1 to 4 of Vol. IX. Printed by the Commercial Press, Ltd., Hongkong, 1931.

UNLESS one has made a careful and very recent study of Chinese affairs, and unless one knows China, one is apt to think of that country as in a state of disorganization that has lasted for years and that has disrupted government, commerce and education to an appalling degree. With a knowledge only of the newspaper headlines, and not taking into consideration the great size of that country and the rather primitive means of communication, one does not realize that life goes on uninterrupted in great regions, and that, while battles may be fought in an adjoining province and while banditry may exist in the next town but one, work is going on steadily in literally thousands of communities.

In this way they have been going on at Lingnan University. This institution, formerly known as Canton Christian College, has been in existence for forty-three years. Since the Boxer rebellion, it has been located on Honan Island. This is an island formed by two branches of the Pearl River and is about two and a half miles from Canton proper, communication being by boat. The university is a private institution, is non-denominational and coeducational. In 1928 a new Science Hall was built, having been financed by the Rockefeller Foundation and by Mrs. Willard Straight.

Volume VII of the *Science Journal* is the first of two volumes of the proceedings of a science conference held on the occasion of the formal opening of the new science building which is called Willard Straight Hall, on October 19, 1928. Volume VIII will appear shortly, including the rest of the proceedings of that conference. Four parts of Volume IX, with miscellaneous contents, have been published in advance of the appearance of Volume VIII.

The proceedings of the formal opening seem to have been of very great interest. Volume VII covers more than 800 pages and carries several plates. The contents are extremely diverse in character. The larger number of papers, however, relate to biology. Contributions had been invited from naturalists in different parts of the world, and the papers are therefore sound and important.

Volume IX shows that there is being published a journal that can not be ignored in scientific circles. The papers in Nos. 1 and 2 include among the subjects treated ornithology, entomology, botany, parasitology, chemistry, meteorology, forestry and anthropology. There is a department entitled "Books" that gives reviews of important volumes, and also a department of "Abstracts."

There is also a department headed "Scientific Notes" that bids fair to become of much importance. It contains short signed notes on differing topics, and the last number added to it a section entitled "General Notes."

Lingnan University is especially strong in scientific work, biology, chemistry and agriculture being emphasized. The journal is sent in exchange for several hundred scientific journals to various countries, and fits in with the plan of the university to establish one of the largest scientific libraries in China.

It is probably unnecessary to add that the journal is published in the English language. I am told by Dr. William E. Hoffman, the chief editor, that nearly

all the instruction in the college is given in this language.

To give an idea of the varied contents of the journal, I list as follows some of the titles of articles that appear in Nos. 1 and 2 of Volume 9: Lefever, Rufus H., "Summer Birds of Hongkong"; Takahashi, R., "Notes on Some Chinese Aphididae"; Tai, F. L., "Studies in Gymnosporangia on Juniperus Chinensis —I. Gymnosporangium Yamadae Miyabe"; Merrill, E. D., "A Third Supplementary List of Hainan Plants"; Werner, F., "Rana Leporipes, a New Species of Frog from South China, with Field Notes by R. Mell"; Wu, K., "A Study of the Common Rat and Its Parasites"; Frank, Henry S., "The Le Chatelier-Braun Principle. I. A Thermodynamic Proof"; Wu Ma Na, "The Solubility of Sodium Chloride in Saturated Solutions of Sodium Chlorate"; Fenzel, G., "Problems of Reforestation in Kwangtung with Respect to the Climate."

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MODIFICATION OF KROGH'S DIFFERENTIAL MANOMETER

IN 1929 Meyerhof and Schmitt[1] published an account of an investigation conducted by them on the respiratory quotients of nerves at rest and in activity, in the course of which they described a manometric method of determining in one operation the consumption of oxygen and the output of carbon dioxide. A solution of barium hydroxide and one of citric acid were kept separately in receptacles in the lower part of a bulb designed on the principle of one contructed by Warburg,[2] who used it for a different purpose. These investigators used three types of the bulb, differing in minor details. Carbon dioxide was absorbed by the barium hydroxide, and the consumption of oxygen was determined. Then the carbon dioxide was liberated by the addition of the citric acid to the barium carbonate formed. This procedure furnishes a convenient, rapid method for estimating the respiratory quotient.

The writer has found that this method can be used with a Krogh manometer,[3] after that instrument has been slightly modified by indenting the bottom of each of its bulbs to form two separate depressions for the reception of about one cc of solution in each. Bulbs of this type can be made by any glass blower. The partition between the two depressions should be made entirely across the bottom, and reach upward to about the center, of the bulb, as shown in Fig. 1.

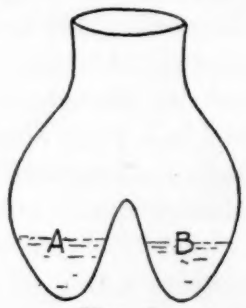

FIG. 1

Into A, Fig. 1, about 0.4 cc of a 5 per cent. solution of barium hydroxide is accurately measured, and into B the same quantity of a 15 per cent. solution of citric acid; in this bulb, let us suppose, is suspended the insect or other object under investigation. Into the compensating bulb, of the same construction, are measured the same quantities of these solutions, not for any chemical reaction, but to equalize the available air spaces in the two branches of the manometer. While the two solutions in the insect-containing bulb remain separate the barium hydroxide there absorbs the carbon dioxide given off by the insect, thus changing the position of the liquid, at first in equilibrium, in the two legs of the manometer. Suitable readings (on the attached scale) for the positions of the liquid, together with the known constants of the instrument, afford data for computing the oxygen consumption.

After these readings have been made the manometer is carefully raised from the water-bath in which, for suitable and uniform temperature, the bulbs have been immersed, and the two solutions in the insect-containing bulb are quickly mixed by gentle agitation until the mixture becomes clear, the stopcock remaining closed. The bulbs are then replaced in the water-bath. By very careful manipulation the mixing of the two solutions may be accomplished without removing the bulbs from the water bath, but apparently this precaution is of no advantage. The citric acid liberates the carbon dioxide from the barium carbonate formed during the insect's consumption of oxygen, thus producing a movement, in the opposite direction, of the manometer fluid, which immediately reaches a constant level. Readings are then made for the new position of the manometer fluid, after which all needed data are

[1] O. Meyerhof, and F. O. Schmitt. "Über den respiratorischen Quotienten des Nerven bei Ruhe und Tätigkeit," *Biochem. Ztschr*, 208: 445–455. 1929.

[2] O. Warburg. "Methode zur Bestimmung von Kupfer und Eisen und über den Kupfergehalt des Blutserums," *Biochem. Ztschr*, 187: 255–271. 1927.

[3] A.Krogh. "Ein Mikrorespirationsapparat und einige damit ausgeführte Versuche über die Temperatur-Stoffwechselkurve von Insektenpuppen," *Biochem. Ztschr*, 62: 266–279. 1914.

available for computing the carbon dioxide evolved. Corrections for volume should be made on account of the changes in the bulbs; otherwise the calculations are exactly similar to those for the method hitherto used with the Krogh manometer.

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THE PHYLLOTAX—A PRACTICAL APPARATUS FOR DEMONSTRATING DIVERGENCE

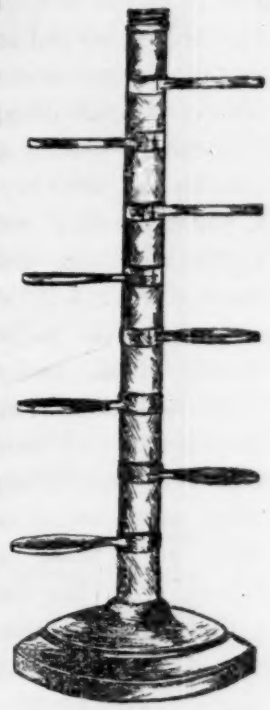
TEACHERS of botany have often found it difficult, if not impossible, to obtain adequate plant specimens for the purpose of properly illustrating their lectures on divergence. Even when such plant specimens are available, the fact remains that quite a number may be required to illustrate the main types of divergence.

I devised a few years ago an apparatus which, I think, will prove of some use. It consists of a metal stem along which are placed, at regular intervals, a number of leaves, each one being attached to a ring revolving about this stem, in order to give any desired divergence. If the divergence $\frac{1}{2}$ is wanted, two leaves should be met at regular intervals before the observer returns over the starting-point. Let us take a less simple case, for example the divergence $\frac{2}{5}$, which requires two complete revolutions around the stem before a leaf is found above the starting-point: there should then be five leaves, each forming with the next an angle of 144°.

All divergences have a value ranging from $\frac{1}{5}$ to $\frac{1}{2}$. The most common ranges are from $\frac{1}{3}$ to $\frac{2}{5}$, and are known as the "normal series." In illustrating divergence, it is of course more suitable to use the simplest cases, *i.e.*, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, and $\frac{2}{5}$. Such divergence as $\frac{3}{7}$ or $\frac{3}{8}$ can not be illustrated in a lecture. It might be convenient to indicate on the apparatus Fibonacci's angle: 137° 30′ 28″. This angle is the limit towards which the different values of the normal series converge, but it should never be considered as a type of divergence in itself.

DESCRIPTION OF THE APPARATUS

A metallic stem is vertically fixed on a stand. On the stem are placed, as stated before, equidistant revolving rings, each bearing a leaf. Every one of the rings has inscribed on it the fractions denoting divergence. It will be easily understood that the relative position of the fractions differs from one ring to the other. One would naturally expect to find these fractions on the fixed axis of the stem, *i.e.*, between the rings; setting every leaf to a predetermined fraction would give the divergence wanted. But this process has its drawbacks since, for instance, to get the divergence needed, we have to revolve the whole apparatus to find the figures. On the other hand, if the fractions are on the revolving rings and the stopping points for each leaf along the same vertical of the fixed axis of the apparatus, the observer will have only to face the stopping points and to move each leaf until the fractions for a given divergence are all set on the said stopping line.



HOW THE FRACTIONS ARE PLACED ON THE DIFFERENT REVOLVING RINGS

The first ring, whether at the top or at the bottom, will always remain in the same position for all demonstrations of divergence. On this first ring, it is not the leaf that is brought to the stopping mark, but a chosen point which is found on the ring 45° from the leaf. This prevents any fraction from occurring on the succeeding rings at the point of attachment of the leaves. Otherwise rather broad rings would be required for easy reading of fractions on account of the leaf at that point. The positions of all fractions on the other rings depend on the position of the mark on the first ring. The fraction $\frac{1}{2}$ on the second ring will be found 180° away from the mark of the first leaf, *i.e.*, 225° from the point of attachment. The fraction $\frac{1}{3}$ on this same ring will be 120° apart, instead of 180°, *i.e.*, 165° from the leaf. On the third ring the fraction $\frac{1}{2}$ will be 180° away from its position on the second ring and this will bring the third leaf to the original position of the first one. On this third ring the fraction $\frac{1}{3}$ will be 120° away from its position on the second ring, *i.e.*, 285° from the leaf. And so on.

JACQUES ROUSSEAU

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SPECIAL ARTICLES

ONCHOCERCIASIS IN GUATEMALA

THE Harvard Expedition for the investigation of onchocerciasis in Guatemala has been working in that country since January 27. The disease in Guatemala is characterized by the formation of nodular tumors situated on or in the region of the head. The fibromatous tumors are of parasitic origin, and the adult male and female *Onchocerca coecutiens* are situated

in the central portion of the tumor. We have been able to demonstrate that three species of *Eusimulium* flies are concerned in the transmission of the disease. For the present and until careful comparison has been made with published descriptions and museum specimens these species have been designated as follows: Species A (probably *Eusimulium avidum,* Hoffmann), a small black fly some 2 mm in length; species B (probably *Eusimulium ochraceum,* Walker) about the same size or a little smaller with yellow thorax, the abdomen half yellow and half black and the legs mostly black; and species C (probably *Eusimulium mooseri,* Dampff), slightly larger than the others, with the thorax and most of the abdomen yellow and the legs very extensively yellow. All stages of development of *Onchocerca coecutiens* have been repeatedly observed in these flies, and the development has been traced from the time the fly just bites the infected individual and thus ingests the microfilariae from his skin, on through their passage and development in the thoracic muscles, head and proboscis. We have been fortunate in securing permanent specimens of the infective filarial form passing through and emerging from the labium of the proboscis. In this study, 4,572 flies have been dissected and examined microscopically. Other insects and particularly culicine mosquitoes are not concerned with the transmission of the disease.

The mosquito has a considerably longer proboscis than the *Eusimulium* fly and evidently inserts the proboscis deeply in sucking blood. The microfilariae of *Onchocerca,* which are not encountered naturally in the blood, but are found in the lymphatics of the skin, are not even ingested by the mosquito when it is fed on infected individuals. Possibly also the saliva of the mosquito repels the microfilariae of *Onchocerca coecutiens.*

In some of the cases in which the tumors have existed for long periods of time, disturbances of the eyes and loss of vision occur. We have been able to demonstrate microfilariae in such cases in sections of the peri-corneal conjunctiva, cornea and iris removed at operations or at autopsy. The continued presence and passage of the microfilariae through the lymphatics of the eye for long periods of time apparently give rise to an inflammatory condition and to a perivascular infiltration, in perhaps somewhat the same manner as occurs from the action of the trypanosome in the tissues of the central nervous system in sleeping sickness. In the course of time, peri-corneal, conjunctivitis, keratitis and iritis may result in such cases.

We have also investigated the blood and serum in the disease. Eosinophilia is present, and counts of eosinophiles of from 25 to 50 per cent. are usual. The serum of some of the cases of long standing gives a precipitin reaction with an aqueous or alcoholic extract of the tumors employed as antigen. However, a rabbit serum prepared by repeated intravenous inoculation of the animal with an extract of the tumors gave no such reaction.

In the clinical studies 1,383 individuals have been examined and the tumors removed in 261 cases. Some of the tumors have been hardened in Zenker's solution for histological study, while others have been used for the preparation of antigen and still others have been digested and dissected to obtain entire for study the adult male and female parasites.

The tumors (and the adult parasites within them) can be easily removed by operation under a local anesthetic, but in some cases the microfilariae continue to circulate in the body and are demonstrable in the skin and in some cases in the eye for at least several years. In order to rid the patient of the microfilariae which persist after removal of the tumors, experiments have been performed to discover a satisfactory filaricidal substance. Using a technique which gives a suspension in normal saline solution of an enormous number of motile microfilariae, it has been found that *in vitro* plasmoquinin in dilutions up to 1 to 10,000 effectively destroys the microfilaria. The motility of almost every parasite in the microscopical field ceases and they become apparently lifeless within thirty seconds; the several in the microscopical field which are not immediately killed no longer exhibit any lively movement (but may continue to bend more or less for 10 to 15 minutes) and are dead within about 20 minutes. Quinine in a solution of 1 to 5,000 produces somewhat similar results, but its lethal action is somewhat less marked while antimony compounds, neosalvarsan and mercurochrome are relatively ineffective. A serum prepared by repeatedly inoculating a rabbit with extracts of the adult filariae and embryos and with the tumors themselves has shown no filaricidal properties.

The members of the expedition, besides myself, are Dr. J. Bequaert, entomologist of the department of tropical medicine at Harvard University, Dr. M. Ochoa, parasitologist of the Board of Health of Guatemala, and Mr. B. Bennett, technician of the department of tropical medicine.

RICHARD P. STRONG

MOCÁ, MAY, 1931

INTRANUCLEAR INCLUSIONS IN LARYNGOTRACHEITIS OF CHICKENS

BEACH[1] has reported from this department the filtrability of the virus of laryngotracheitis in chickens. We wish in this place to record briefly the results of a histological study of spontaneous and

[1] J. R. Beach, SCIENCE, 72: 633, 1930.

experimentally produced cases and the finding in both of intranuclear inclusions.

The lesions are restricted to the respiratory tract and occur first and are most pronounced in the larynx and trachea. At the outset the surface epithelial cells show various forms of cellular degeneration, but inflammatory processes of various degrees in the submucosa and other parts of the mucous membrane soon follow. The destructive process in later stages is due to the combined effect of the virus and mechanical factors produced by edema, cellular infiltration, hemorrhages, and in a few instances secondarily invading bacteria. A small number of animals show bronchitis and peribronchitis, pneumonic areas, and hemorrhages in the lungs, while involvement of the nasal passages, communicating sinuses and eyes seems to be dependent upon the point of entrance of the virus.

Certain intranuclear inclusions can be demonstrated in the epithelial cells lining the mucous membrane as well as in those of the mucous glands of the larynx and trachea in many cases. These inclusions consist of round, oval or irregularly shaped, sharply outlined, homogeneous, acidophilic masses. Usually a single inclusion occurs in a nucleus. The size may be small, but it is often so large as to occupy most of the central portion of the nucleus, which then may be considerably enlarged. The nucleoli of the affected cells are commonly attached to the nuclear membrane, and the space between the inclusion and the nuclear membrane remains entirely unstained. The inclusions resist the solvent action of acetic acid, alcohol and chloroform; they do not contain fat or iron, but give the Feulgen reaction for thymonucleic acid slightly. Silver impregnation shows small argentophilic granules inside the inclusions. The inclusions described as well as other changes in the nuclei bear a close resemblance to similar structures found in such virus diseases as herpes, varicella, virus III of rabbits and submaxillary gland disease of guinea pigs.

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IONIC EQUILIBRIA IN THE SERUM IN RELATION TO THE CRITICAL TEMPERATURE

IN our systematic researches on the critical temperature of blood serum (around 56° C.) we have so far purposely neglected the part played by the salts and we have been able to account for the observed phenomena by means of simple hypotheses which explained the facts satisfactorily without necessitating any assumption concerning ionic phenomena. However, we did not overlook this factor, neither did we underestimate its importance. We were only compelled to leave it aside in order to simplify arbitrarily a problem already so complex. We have now attempted to study this side of the question, and the purpose of this paper is to report a few preliminary results.

As it was necessary to respect as much as possible the integrity of the protein molecules, we only used distilled water as a means of disturbing the normal salt equilibrium of the serum. The first step was to study quantitatively the equilibrium: albumin-globulin, when progressive amounts of pure water were added to normal serum. The method used consisted in measuring the amount of light scattered at right angles of the incident light (more accurately, the value of $\log \frac{I_o}{I}$) as a function of the dilution. As the addition of water brings forth a precipitation of the globulins, the light scattered by the solution increases. It is known that the amount of light scattered is proportional to the number of particles (Lord Rayleigh), provided the latter are small with respect to the wave length of the light used and nearly spherical in shape. It was found that the addition of 1, and even 2 cc of water to 1 cc of serum did not determine much cloudiness, while if 3 cc were added the increase in the scattered light was very important. In other words, there is, in general, a sharp break in the curve around the point corresponding to a concentration of salts equal to 33 per cent. of the normal. If we assume that the value of the ratio $\frac{I_o}{I}$ is equal to 1 for pure serum, an addition of 200 per cent. of water will bring it to

TABLE I

LIGHT SCATTERED BY NORMAL HORSE SERUM, AFTER ADDITION OF DISTILLED WATER

Cc of water added to 1 cc of serum	Relat. concent. of salts, per cent.	Readings $= \log \frac{I}{I_o}$	
		After 1 hour	After 4 hours
Ser. undiluted	1	2.18	2.23
+ 1 cc water	0.50	2.12	2.14
2	0.33	2.06	2.08
3	0.25	1.54	1.50
4	0.20	1.30	1.30
5	0.168	1.17	1.21
6	0.143	1.15	1.16
7	0.125	1.12	1.14
8	0.115	1.12	1.14
9	0.100	1.13	1.15
10	0.091	1.15	1.17
11	0.083	1.17	1.19

about 1, 3, while an addition of 300 per cent. raises it to nearly 4. Between the concentration 0.33 and 0.25 per cent. of salts we observe therefore a particular instability of the serum, and the instability was maximum, in our experiments (normal horse serum, collected without especial precautions), immediately around 0.33 per cent. Table I gives the results of one experiment.

When the serum is heated for 10 minutes previous to the addition of water, the fragility of the system albumin-globulin is increased, as shown by Table II. The increase in the amount of scattered light (expressed in the table by *decreasing* figures) begins sooner, in a more abrupt fashion, but only when the serum is heated above 55° C. When heated to 60° (always for ten minutes) the curves are totally different in shape.

TABLE II

LIGHT SCATTERED BY NORMAL HORSE SERUM UNHEATED AND HEATED PREVIOUS TO ADDITION OF DISTILLED WATER

Cc of water added to 1 cc of serum	Unheated	Heated at 56°	Readings = $\log \frac{I}{I_o}$	
			Heated at 60°	Heated at 64°
0	1.98	1.96	1.72	1.19
0.5	1.98	1.96	1.62	1.09
1	1.99	1.92	1.59	1.05
1.5	1.98	1.84	1.54	1.00
2	1.95	1.68	1.53	1.03
3	1.63	1.56	1.39	1.05
4	1.33	1.47	1.32	1.04
5	1.25	1.40	1.31	1.07

It was then attempted to determine the rate of sedimentation of the precipitated globulins, as their aspect was decidedly different in the cases of unheated serum, and of serum heated above 58°. In order to obtain figures proportional to the rate of sedimentation, it was only necessary to observe the scattered light at regular intervals of time, and to take the readings. This was very easily done in the instrument previously described.[1]

Fig. 1 expresses the results of one set of experiments, made with serum diluted with 5 times its volume of distilled water.

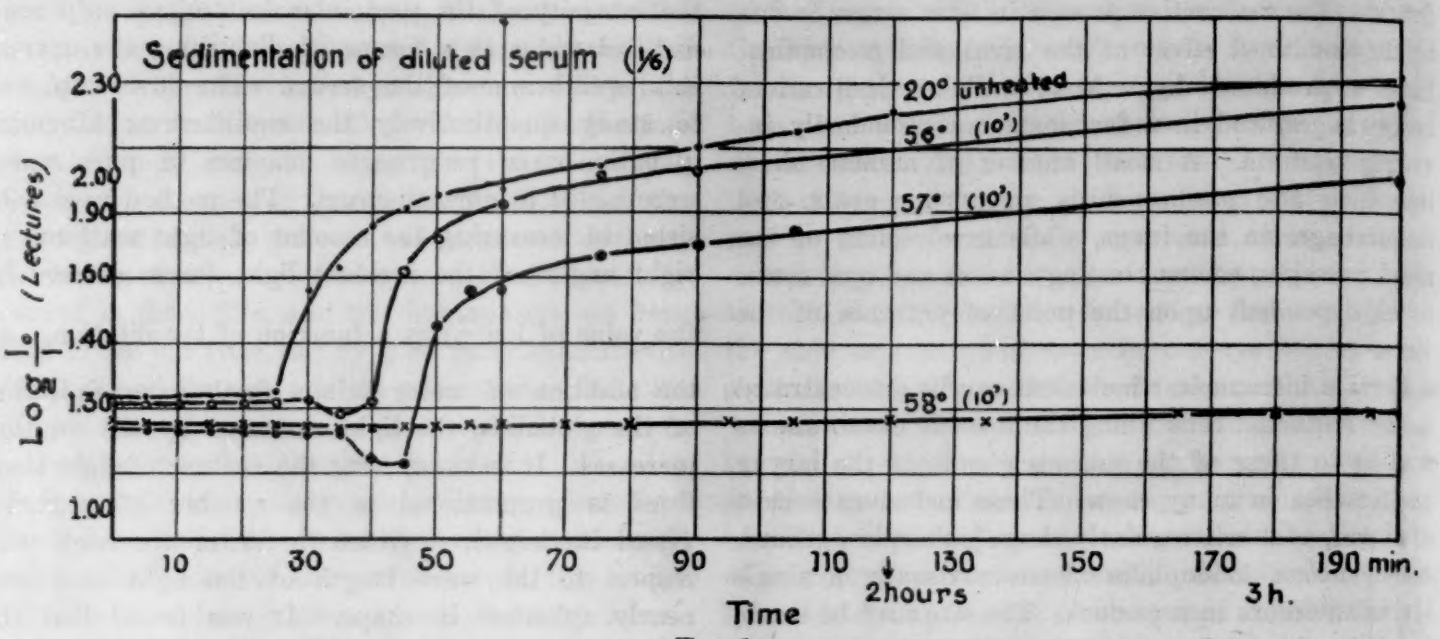

FIG. 1

It will be seen that the sera heated for ten minutes at 56° and 57° (in sealed tubes, of course) show a slight decrease in the value of $\log \frac{I_o}{I}$ (which correspond to a momentary *increase* in the amount of scattered light) after 35 minutes in the first case, and 40 minutes in the second case. Unheated serum shows a sudden and important *decrease* in the amount of scattered light, after 25 minutes, while the same decrease is observed after 40 minutes in the serum heated at 56° and after 45 minutes in the serum heated at 57°. The curves are practically parallel. This decrease is obviously due to the decrease in the number of scattering particles due to settling, and is a function of their number. The settling of the globulins can then be followed quantitatively. But a very important phenomenon was observed when the serum was heated for 10 minutes up to 58°, namely, the fact that *there was no decrease at all in the scattered light, no settling.* Fig. 1 shows indeed that the figures expressing $\log \frac{I_o}{I}$ are practically constant for two hours, and that even 18 hours later the change is much less marked than that which occurs in the serum kept at 57°. When the serum was heated at 60° no change whatever was observed in 22 hours.

[1] P. L. du Noüy, *Ann*, Inst. Pasteur, 45: 251, 1930.

The globulins do not settle, and remain in suspension for many days. The pH of the solution plays an important part in the phenomenon; but this side of the question will be taken up in another paper. Suffice it to say at present that the solution must be slightly acid in order to observe an immediate difference in the rate of sedimentation. With less acidity, the phenomenon is only postponed.

In the serum unheated, or heated below 57°, the phenomenon of sedimentation starts very abruptly, and is very rapid at first, as in a given volume the number of scattering particles is more than halved in 5 minutes. However, as Rayleigh's formula only holds for particles which are small with respect to the wave-length of light, and as we have at present no information concerning their size, we can not as yet interpret the figures satisfactorily.

Nevertheless, a new phenomenon can be added to the four which, as we have already shown, characterize the critical temperature of serum, namely, viscosity, rotatory power, scattered light, depolarization factor. But this last one brings forth something more, as it applies to the behavior of the globulins alone, when the total serum was heated at or above 58°. Without drawing any hasty conclusions, one can not help wondering if the destruction of the complement might not be connected primarily with the globulin fraction of the serum.

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THE POSSIBLE RÔLE OF MICRO-ORGANISMS IN THE PRECIPITATION OF CALCIUM CARBONATE IN TROPICAL SEAS[1]

FOLLOWING the same procedure carried out in the investigation of marine "calcium bacteria" by Drew, Kellermann and Smith, Lipman and others, extensive personal observations were made in the region of Andros Island, while the experimental studies were carried out in the laboratories of soil microbiology at the New Jersey Agricultural Experiment Station, at New Brunswick, New Jersey. Only a brief summary of these experiments may be presented here. The results so far obtained make it appear that the question concerning the rôle of micro-organisms in the formation of sediments in the ocean, especially their activity in the precipitation of calcium carbonate, may be reopened again.

In the course of a trip of three weeks' duration during the months of March and April, 1930, to the Great Bahama Banks, to Andros Island and to a smaller island off the west coast of Andros, or Williams Island, various samples of mud were collected with special instruments, at several carefully selected locations and from different depths, in order to carry out the investigations in the laboratory named above; likewise direct microscopic observations of the microflora of the material collected were made immediately, soon after the samples were taken.

At the laboratory in New Brunswick, experiments were begun first by counting the numbers of micro-organisms in the mud, since to date there is no sufficiently definite information dealing with the number or with the quantitative distribution of organisms which might possibly take a direct or indirect part in the process of calcium carbonate precipitation. These experiments led to the discovery of certain interesting and characteristic differences in the different regions of the ocean.

In agreement with the observations of the earlier investigators, it was discovered—if we disregard the water of the high seas with its well-known low bacterial population—that relatively few bacteria occur in the white calcium carbonate mud of the Bahama Banks and off the west coast of Andros; the numbers of bacteria in the different layers of this mud, as determined by the plate method, vary from a few cells to 5,000, 10,000 and 100,000 cells per gram of moist mud. At other locations, however, as on the coast of Williams Island, and especially in the mangrove swamps situated farther inland, the number of bacteria increase considerably. The surface layers of the mangrove swamp of Williams Island, for example, contain over sixteen million bacteria per gram and, even at a depth of four feet, over two million bacteria could be found in one gram of material.

Among the organisms which have been isolated by special culture methods from the samples, there were many forms which have been for the first time found to exist on the coast of this interesting island. The existence of a typical microbial population was found both by direct examination and by laboratory studies.

Of this population, sulphur bacteria, Oscillatoria, certain diatoms and Protozoa play the chief part. It was possible to identify several colorless and red colored Thiobacteria and it was further possible to

[1] This is one of a number of papers resulting from The International Expedition to the Bahamas in 1930. The object of the expedition was to collect all possible data concerning the relation of the stability of the Bahama "Block" to the origin, migration and alteration of the sediments which mantle its surface. A further paper "On the Decomposition of Agar-agar by an Aerobic Bacterium," by Dr. Selman A. Waksman and Dr. Bavendamm, is being published. Dr. Bavendamm was appointed to the staff of the expedition by the Deutsche Forschungsgemeinschaft. All the bacteriological work was done with the advice and under the direction of Dr. Waksman at the New Jersey Agricultural Experiment Station.—Richard M. Field.

assign a new position to the rare *Beggiatoa mirabilis* of the Bahama Islands.

It is astonishing that such conspicuous forms, such as the sulphur bacteria, have never been mentioned before. It is equally surprising that the numerous anerobic bacteria found in the mud have been similarly disregarded.

As to the organisms which may be responsible for the precipitation of calcium carbonate, the following observations may be reported here:

Apart from the kinds which Drew and others have termed erroneously "calcium bacteria," going so far as to attach special names to them, there were found in many places numerous urea bacteria which to this day have escaped observation. These bacteria, like the denitrifying forms observed by Drew and other scientists, are able to precipitate calcium carbonate under certain conditions. Also the strictly anerobic sulphate reducing bacteria, which seem important in the process of calcium carbonate precipitation, were found to exist everywhere.

The presence of very active cellulose and hemicellulose destroying bacteria attracted special attention. These organisms were subjected to a closer investigation. Some of the bacteria are noted for their ability to dissolve agar-agar made from brown and red algae; these bacteria occurred in such vast quantities that they are believed to be responsible not only for the decomposition of the abundant organic matter in the mangrove swamps, but together with other bacteria they might be indirectly partly responsible in the precipitation of $CaCO_3$.

The author does not agree with Lipman's ideas (1929), whose conclusions on this subject have been based on experiments which were not sufficiently convincing; rather he is of the opinion that in reference to the vast calcium carbonate sediments in the tropical sea of to-day and of former geological periods we have to deal not with strictly chemical-physical, but primarily with microbiological processes. These results were obtained not only from the inspection of crude and pure cultures of the various organisms in the laboratory, but also from personal observation of the conditions *in situ*, as considered from the botanical-bacteriological-hydrobiological view-point; finally, from simple conclusions resulting from a study of bacteriological, botanical, geological, chemical, physical and oceanographic literature.

The author believes that the bacteriological process of calcium carbonate precipitation may be confined to certain locations. The shallow and richly manured mangrove swamps in particular may assist one in reaching this conclusion, for they represent an ideal habitat of bacteriological life, and it is here that we find especially pronounced bacterial activities.

The assumption that mangrove swamps or similar places represent the natural locations for the microbiological calcium carbonate precipitation is strongly supported by the observations of the geologists participating in the expedition. It is their opinion that we were possibly dealing with fresh or brackish water sedimentations. This view is in no way opposed to the results of the microbiological investigations, since we know that many of the bacteria mentioned may adjust themselves easily to a varying concentration of salt in the water, also that for similar processes related conditions have been found to exist.

The chemical-physical factors of this important geological process should of course not be disregarded. However, their importance may be no more than secondary and may serve to explain why such large quantities of calcium carbonate have not been precipitated at other places on the earth which possess virtually the same microflora and the same external features as the tropical sea.

We are dealing here with a complicated but not inexplicable collaboration of various factors which serve to make the problem of calcium carbonate deposits intelligible. How the different processes are probably related to each other and how the necessary investigations in the future must be carried out is to be discussed later in a detailed publication in German, probably to appear in the *Internationale Revue für die gesamte Hydrobiologie und Hydrographie.*

WERNER BAVENDAMM

TECHNISCHE HOCHSCHULE,
DRESDEN

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